A Retrospective study on Thoracic outlet syndrome

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY FOR THE DEGREE OF M.S. BRANCH I - GENERAL SURGERY EXAMINATION TO BE HELD IN MARCH-2009

Certificate

This is to certify that "A Retrospective study on Thoracic outlet syndrome ", which is being submitted as thesis requirement for M.S. Degree Branch I – General Surgery examination of the Dr. M.G.R. Medical University of Tamil Nadu, is a bonafide work of the candidate Dr.Beulah Roopavathana.S

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Certificate

This is to certify that the topic entitled “A Retrospective study on Thoracic outlet syndrome ” is a bonafide work done by Dr. Beulah Roopavathana.S , post graduate in General Surgery of Christian Medical College, Vellore. This work has been carried under my guidance and supervision in partial fulfillment of the regulation of Dr. M.G.R. Medical University of Tamil Nadu for Master of Surgery- Branch I (General Surgery) examination to be held in March 2009.

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I thank God for His mercy.

Contents

Abstract

Background:

Thoracic Outlet Syndrome (TOS) refers to clinical problems that develop as a result of neurovascular compression in the unique anatomic region in the neck dominated by the anterior and middle scalene muscles, the first rib, and their associated structures.

Methods:

Our experience with consecutive operations for TOS, over a period of 12 years from 1995 to 2007, has been reviewed retrospectively. Preoperative symptoms and signs, investigations, surgery done, complications and the outcome of surgery are analysed.

Results:

A total of 56 patients underwent 60 operations for decompression of TOS. Forty eight patients had decompression by the transaxillary approach. In 12

patients, a supraclavicular approach was used. There was no operative mortality in this series. The operative complications included pneumothorax in 4 patients,

vascular injury in 1 patient. The mean duration of postoperative hospital stay was 6.6 days.

Conclusion:

The results of the present study shows presence of cervical rib to be the cause of thoracic outlet syndrome, which could mean reluctance in the diagnosis of the same in the absence of a cervical rib in our set up. The presence of complete cervical rib in all patients with vascular pathology might mean a need for systematic evaluation of vascular pathology in patients with complete rib. It also confirms that transaxillary excision of the first rib is a surgical procedure associated with very low morbidity. It can be offered as an early option for patients with thoracic outlet syndrome. Supraclavicular approach is recommended if exposure of the subclavian artery is required for vascular reconstruction.

Introduction

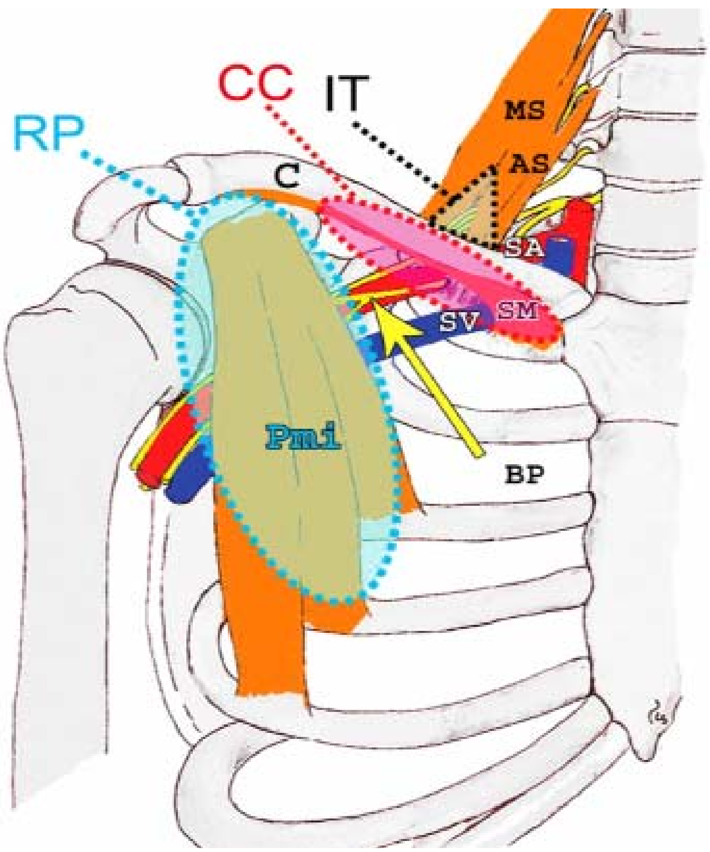
The major developments in the evolution of understanding the thoracic outlet syndromes is presented in a chronologically historical record beginning with the first mention of a cervical rib by Galen in the second century A.D. Appreciation of the vascular and neurologic types of TOS progressed slowly through the centuries until detailed clinical studies were presented in the early 1900s. Interest in these syndromes increased steadily since then with description of the effectiveness of first rib resection by Murphy in 1910, and scalenotomy without cervical rib resection favored by Adson in 1927. The term "thoracic outlet syndrome" was coined by Peete et al in 1956 to encompass all the forms and causes of neurovascular compression in the base of the neck. Although rib resection may be considered the oldest operation on mankind, its application to treatment for TOS became popular only after Clagett's description of the posterior periscapular approach in 1962 and the transaxillary approach in 1966. The techniques of arteriography and venography were introduced in the 1960s and remain the hallmark for evaluation of the arterial and venous types of TOS. The neuroelectric studies introduced by Jebsen in 1968 have become popular, but offer little definitive diagnostic information for the neurogenic form of this syndrome. Recent histochemical studies of scalene muscles have shown important changes at the cellular level of the scalene muscles with trauma leading to TOS. The basic cause of the various neurovascular symptoms relates to anatomic abnormalities, either congenital or developmental, that cause abnormal compression and irritation of the major nerves and vessels in the thoracic outlet, causing certain people to have anatomic susceptibility to develop symptoms under certain conditions[1].

Literature review:

Anatomical basis

The thoracic outlet, or cervicothoracobrachial junction, includes three confined spaces, extending from the cervical spine and the mediastinum to the lower border of the pectoralis minor muscle, which are potential sites of neurovascular compression. These three compartments are the interscalene triangle, the costoclavicular space, and the retropectoralis minor space. The interscalene triangle is the most medial of these compartments. It is limited anteriorly by the anterior scalene muscle, posteriorly by both the middle and posterior scalene muscles, and inferiorly by the first rib. The anterior scalene muscle originates from the anterior tubercle of C3–C6 and inserts inferiorly onto the scalene tubercle of the first rib. The middle scalene muscle originates from the posterior tubercle of C2–C7 and inserts inferiorly onto the first rib behind the scalene tubercle, from which it is separated by the subclavian groove. The posterior scalene muscle is the deepest of the three scalene muscles. It arises from the posterior tubercle of C4–C6 and inserts inferiorly onto the second rib. The interscalene triangle is crossed by the subclavian artery, which occupies the floor of the space, and by the three trunks of the brachial plexus. The upper (C5–C6) and middle (C7) trunks cross the upper part of the interscalene triangle above the subclavian artery. The lower trunk (C8–T1) is located in the inferior part of the interscalene triangle, behind the posterior part of the subclavian artery. The subclavian vein does not cross the interscalene triangle but runs beneath the anterior scalene muscle before joining the internal jugular vein to form the brachiocephalic vein. The intermediate compartment of the thoracic outlet is the costoclavicular space. This compartment is limited superiorly by the clavicle, anteriorly by the subclavius muscle, and posteriorly by both the first rib and the middle scalene muscle. The subclavius muscle originates from the junction of the first rib with its costal cartilage; its fibers run upward and laterally and insert into the inferior surface of the clavicle. This space contains the subclavian vein anteriorly, the subclavian artery immediately posterior to it, and the three cords of the brachial plexus, arranged in a triangular configuration. The retropectoralis minor space is the most lateral of the three compartments. It is limited by the posterior border of the pectoralis minor muscle anteriorly, by the subscapularis muscle posteriorly and superiorly, and by the anterior chest wall posteriorly and inferiorly. The neurovascular arrangement in this space is quite similar to that seen in the costoclavicular space. Just lateral to the pectoralis minor muscle, the cords divide into five terminal branches (median nerve, ulnar nerve, musculocutaneous nerve, axillary nerve, and radial nerve). [2]

Figure 1: anatomy of thoracic outlet



Pathophysiology and clinical subtypes

Knowledge of specific pathophysiologic mechanisms leading to thoracic outlet syndrome is limited. Pathophysiologic response to muscle injury and anatomic factor predisposing to compression of the structures passing through the thoracic outlet are thought to be the cause of the development of thoracic outlet syndrome. Hyperextension injury of the anterior scalene muscle most likely leads to acute and chronic inflammation and a reparative process that involves fibrosis and persistent muscle spasm. Chronic changes in the scalene musculature also include fibrotic contracture and stiffening as well as histopathologic alterations reflecting persistent muscle injury. The resulting changes in the scalene muscles potentiate nerve root compression and irritation, which may be exacerbated by positional effects, resulting in a progression of symptoms. Arterial symptoms are usually due to emboli from a proximal arterial injury that is associated with a combination of bony anomaly and overuse.

The three distinct types of thoracic outlet syndrome are classified according to the primary structure subject to compression:

1. Arterial TOS (accounts for 1%)
2. Venous TOS (accounts for 5%)
3. Neurogenic TOS (approx 95%).

Demography and clinical features

Incidence ranges from 3-80 cases per 1000 people as reported in the U.S. No Indian data is available. It is approximately 3 times more common in women than in men. The onset of symptoms is between 20-50 years.

Neurologic symptoms occur in 95% of cases. The lower 2 nerve roots of the brachial plexus, C8 and T1, are most commonly (90%) involved, producing pain and paresthesias in the ulnar nerve distribution. The second most common anatomic pattern involves the upper 3 nerve roots of the brachial plexus, C5, C6, and C7, with symptoms referred to the neck, ear, upper chest, upper back, and outer arm in the radial nerve distribution. Patients also have paresthesias, often nocturnal, awakening the patient with pain or numbness, loss of dexterity, cold intolerance, occipital headache, weakness, Raynaud phenomenon (usually due to an overactive sympathetic nervous system as opposed to ischemia). History of neck trauma preceding their symptoms is common.

Venous TOS is seen in younger men presents with arm pain often preceded by excessive activity in the arms.

In arterial TOS patients present with arm claudication, pallor, coldness, paresthesias and absent pulses. Symptoms may develop secondary to arterial emboli due to a post stenotic dilatation.

Adson, costoclavicular, and hyperabduction maneuvers are used in diagnosis: 92% of asymptomatic patients have variation in the strength of the radial pulse during positional changes, hence these are unreliable. The elevated arm stress test (EAST) is a relatively reliable screening test. It evaluates all 3 types of thoracic outlet syndrome (TOS). To perform this test, the patient sits with the arms abducted 90 degrees from the thorax and the elbows flexed 90 degrees.

The patient then opens and closes the hands for 3 minutes. Patients with TOS cannot continue this for 3 minutes because of reproduction of symptoms.

Vascular TOS is associated with easily recognized symptoms, whereas the diagnosis of neurogenic TOS is difficult [3].

Vascular symptoms like discoloration or coldness in the hands and fingers can be seen in reflex sympathetic dystrophy. Patients present with persistent vasospasm, disuse edema, and extreme hypersensitivity. The diagnosis of reflex sympathetic dystrophy can be supported by vascular laboratory studies showing abnormal vasoconstrictive responses (cold-pressor tests) or imaging studies of the hand microcirculation, but in most cases, the diagnosis is made on clinical grounds. The identification of this condition in patients with neurogenic TOS is quite important, because it may lead to an earlier recommendation for operative treatment and consideration of concomitant cervical sympathectomy.

Diagnosis

X ray chest or cervical spine usually demonstrate a skeletal abnormality. Color flow duplex scanning, nerve conduction evaluation via root stimulation and F wave, electromyography, cervical myelogram, CT scan, or MRI are the other tests used in diagnosing the presence and clinical type of TOS. Injection of local anesthetic into the belly of the anterior scalene muscle may be used as an adjunct to the clinical diagnosis of neurogenic TOS [4,5,6].

Differential diagnosis of thoracic outlet syndrome

Condition	Differential features
Carpal tunnel syndrome	Hand pain and parasthesias in median nerve distribution; positive nerve conduction studies.
Ulnar nerve compression	Hand pain and parasthesias in ulnar nerve distribution; positive nerve conduction studies.
Rotator cuff tendinitis	Localized pain and tenderness over biceps tendon and shoulder pain on abduction; positive findings on MRI; relief from NSAIDs, local steroid injections or arthroscopic surgery.
Cervical spine strain /sprain	Post traumatic neck pain or stiffness localized posteriorly along cervical spine ; paraspinal tenderness; relief with conservative measures over weeks to months.
Fibromyositis	Post traumatic inflammation of trapezius and parascapular muscles; tenderness, spasm and palpable nodules over affected muscles; may co-exist with TOS and persist after surgery.

Condition	Differential features
Cervical disc disease	Neck pain and stiffness, arm weakness, and parasthesia involving thumb and index finger (C5-C6 disc); symptom improvement with arm elevation; positive findings on CT or MRI.
Brachial plexus injury	Caused by direct injury or stretch; arm pain and weakness, hand paresthesias; symptoms constant, not intermittent or positional; positive findings on neurophysiological studies
Cervical arthritis	Neck pain and stiffness, arm or hand parasthesia infrequent; degenerative rather than post traumatic; positive findings of spine radiographs.

TREATMENT

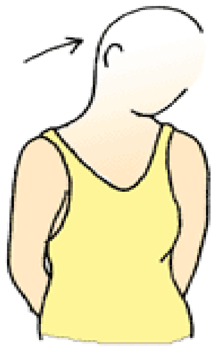
Asymptomatic Lesions

Patients who have bony or soft tissue anomalies that compress the subclavian artery but are free of arterial damage, embolization, and symptoms can be managed with abstinence from strenuous and repetitive arm movement. Modification of arm motion and surveillance for arterial injury may be offered. Anticoagulation and decompression before arterial injury occurs is successful.

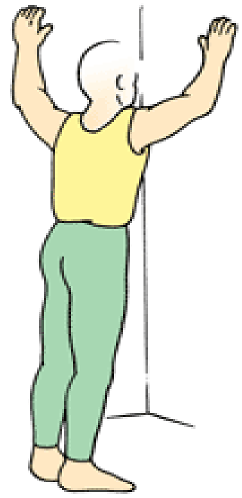
Conservative Treatment

Physical therapy is the initial treatment for patients with neurogenic TOS. The initial treatment is for 4 to 6 weeks, after which progress is reassessed. The initial goals of physical therapy are to maintain and improve the range of motion of the neck and affected upper extremity through a combination of passive and assisted exercises combined with hydrotherapy, massage, use of nonsteroidal anti-inflammatory agents, muscle relaxants, and non-narcotic pain medications as needed [7].

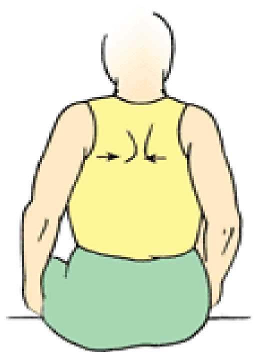
Thoracic Outlet Syndrome Exercises



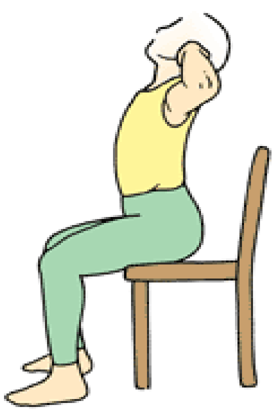
Scalene stretch



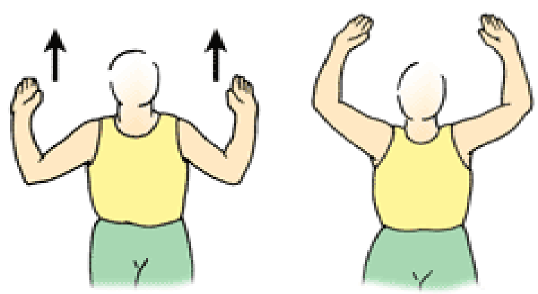
Pectoralis stretch



Scapular squeezes



Thoracic extension



Arm slides on wall

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Benefits are obtained in only 20% to 30% of patients referred for management of neurogenic TOS.

Treatment of arterial thoracic outlet syndrome is indicated for most patients with ischemia and asymptomatic patients with arterial damage. The general therapeutic approach has three goals:

(1) decompression of the structures compressing the artery

(2) removal of the source of emboli

(3) restoration of distal perfusion.

Preoperative identification of the bony abnormality and arterial source enables ideal operative positioning and incisions.

Surgical Treatment

Selection of Operative Approach

The first operations for thoracic outlet compression were focused on treatment of subclavian artery aneurysms in patients with a cervical rib, as described by Coote in 1861. By the turn of the century, the “cervical rib syndrome” was widely recognized, and in 1927, Adson and Coffey described the use of anterior scalenotomy in treatment of this condition, including symptomatic patients without a cervical rib anomaly. Several new operative approaches to TOS were described in the 1960s, including posterior thoracotomy (Clagett) and transaxillary first rib resection (Roos) [8-10]. Combined use of supraclavicular and transaxillary approaches was reported in 1984 by Qvarfordt and associates, followed by further description of the supraclavicular approach by Sanders and Raymer and by Reilly and Stoney.

Current approaches to surgical treatment must take each of these potential contributing factors into account in the selection of the optimal treatment for the individual patient.

Comparison of advantages and disadvantages of surgical approaches

The primary advantages of transaxillary first rib resection are a relatively limited field of operative dissection, a cosmetically placed skin incision, and sufficient exposure to reliably accomplish resection of the anterolateral first rib. This approach also makes it possible to achieve at least partial resection of the anterior scalene muscle as well as identification and removal of most anomalous ligaments and fibrous bands that may be associated with TOS. The disadvantages of the transaxillary approach include incomplete exposure of the structures composing the scalene triangle, difficulty achieving complete anterior and middle scalenectomy or brachial plexus neurolysis, and the necessity for first rib resection in all cases[11]. This approach is also limited when vascular reconstruction is needed, requiring the addition of a separate incision or repositioning of the patient.

The supraclavicular approach carries the advantages of wider exposure of all anatomic structures associated with thoracic outlet compression. It allows complete resection of the anterior and middle scalene muscles as well as brachial plexus neurolysis with direct visualization of all five nerve roots. Symptomatic relief of neurogenic TOS can be achieved by extended scalenectomy without first rib resection, an option permitted by the supraclavicular approach. This approach also allows for resection of cervical ribs, anomalous first ribs, or the normal first rib. A further advantage is that all forms of vascular reconstruction can also be accomplished through supraclavicular exposure; although removal of the anteromedial portion of the first rib and distal control of the vessels may require addition of a second infraclavicular incision, this incision is performed without the need for repositioning the patient [12].

Anterior supraclavicular and infraclavicular incisions provide adequate exposure for most patients who require arterial repair. If decompression only is required, an isolated supraclavicular, axillary, or posterior approach may be suitable. Occasionally a claviculectomy, second rib resection, or even thoracotomy may be necessary to provide adequate decompression or emergency exposure for vascular control.

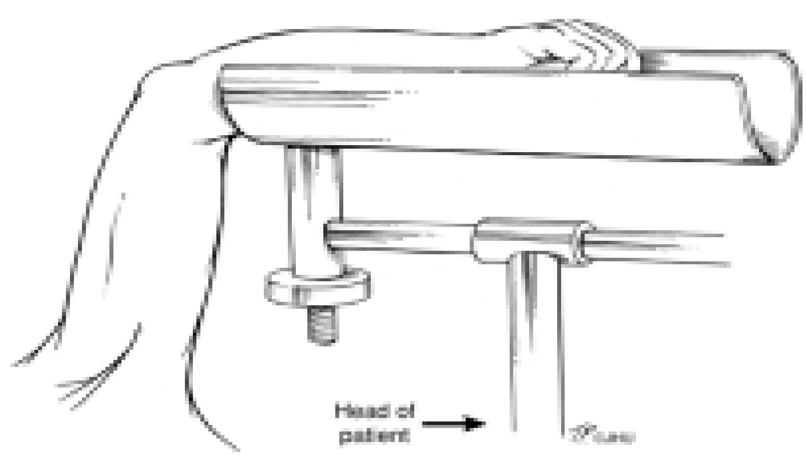
Regardless of approach, preparing the entire upper extremity into the field allows for arm movements that may facilitate exposure.

Transaxillary Approach

Anesthesia and positioning

After induction of general anesthesia, the patient is positioned supine with the back of the table raised about 30 degrees. A small towel pack is placed behind the shoulder to elevate the affected side. The arm is prepared circumferentially and wrapped in stockinette, with the sterile field comprising the neck, upper chest, and posterior shoulder to the scapula. The arm is not placed on a table or crossbar; rather, it is held and positioned by a reliable, flexible, and sturdy assistant [13].

Patient positioning for transaxillary first rib resection.



Incision and approach

A transverse skin incision is made at the lower border of the axillary hairline, extending from the anterior border of the latissimus dorsi muscle to the lateral edge of the pectoralis major muscle. This incision is carried through the subcutaneous tissues directly to the chest wall, with blunt dissection used to establish a plane extending to the apex of the axilla. The long thoracic, thoracodorsal, and second intercostobrachial nerves are identified near the chest wall to avoid direct injury.

Excessive elevation of the arm (unique to transaxillary exposure) is a potential mechanism of injury to the second intercostobrachial cutaneous nerve, resulting in postoperative pain and numbness along the medial aspect of the upper arm.

Operative procedure

The first rib is typically palpable at the upper reaches of the areolar tissue plane along the chest wall. With use of a Deaver retractor to gently lift the subcutaneous tissues and axillary contents away from the chest wall, the first rib is more clearly exposed in the upper aspect of the wound. Exposure obtained during the transaxillary approach is generally limited to the operating surgeon.

It is important that the surgeon be constantly aware of how the assistants are positioned and how the retractors are positioned with respect to the nerve roots and blood vessels. In order to avoid serious injury, the blades of the retractors must not apply excess traction to the neurovascular structures visible above the first rib. In addition to the nerve roots of the brachial plexus, proper attention must be given to avoid traction on the long thoracic nerve, which exits the plane between the middle and posterior scalene muscles before coursing over the first rib to the serratus anterior muscle. Periodic inspection of the retractors and relief for the assistants are recommended, through the use of a staged approach to the operation as described by Machleder.

Once the first rib is sufficiently exposed, the subclavian vein and subclavian artery are identified along with the intervening anterior scalene muscle. These structures are carefully dissected such that the anterior scalene tendon can be encircled with a right-angle clamp just above its insertion onto the scalene tubercle of the first rib, which is typically palpable as a slight bony prominence. The anterior scalene muscle is exposed over several centimeters superior to the first rib, and with care taken to avoid the phrenic nerve, the muscle is divided with a scissors at the highest level feasible. The importance of resecting a portion of the scalene muscle, rather than simply dividing it at the level of the first rib itself, has been underscored by analysis of the factors causing recurrent TOS.

The soft tissues attaching to the inferior and medial borders of the first rib are progressively divided with scissors, beginning with the attachments medial to the subclavian vein (the subclavius muscle tendon and the costosternal and costoclavicular ligaments). A periosteal elevator is used to scrape the inferior border of the rib, extending underneath the rib from the vantage point of the exposure used. The intercostal muscle is fully divided, and the parietal pleura is pushed away from the deep aspect of the rib with blunt dissection. The middle scalene muscle is detached from the superior surface of the rib, posterior to the brachial plexus nerve roots. Although the proximal aspect of the long thoracic nerve is not directly visualized during this maneuver, injury to this nerve must be prevented to avoid postoperative weakness of the serratus anterior muscle. Prevention is best accomplished by keeping the periosteal elevator directly upon the rib during scalene muscle detachment, avoiding any tendency to allow it to stray laterally where the long thoracic nerve can be easily injured. The long thoracic nerve is thereby gently pushed away from the rib indirectly as the middle scalene muscle is detached, effectively protecting it despite the lack of direct visualization.

Once the posterior surface of the first rib is exposed and the T1 nerve root is in full view to protect it from injury, a bone-cutting instrument is carefully applied across the neck of the rib. The lateral portion of the divided rib is pulled downward, and its anterior aspect is cut in a similar fashion, just medial to the subclavian vein at the costochondral junction. The first rib is then fully detached and removed from the operative field. A bone rongeur is used to trim the remaining ends of the bone to a smooth surface well beyond the neurovascular structures.

With an additional amount of extrapleural dissection, the same exposure can be used to perform adjunctive cervical sympathectomy for patients with neurogenic TOS complicated by reflex sympathetic dystrophy.

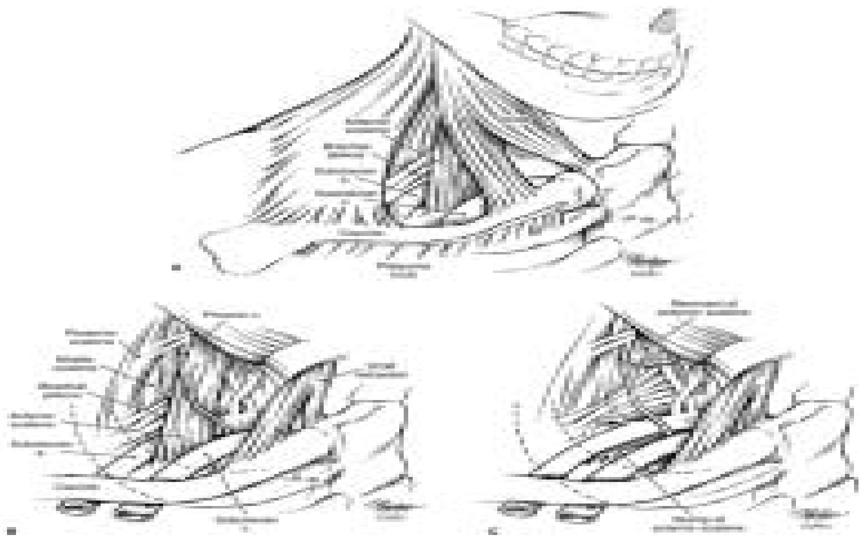
Any additional soft tissue bands found to be crossing the brachial plexus nerve roots are carefully divided, particularly those that may insert upon Sibson’s fascia. After hemostasis is achieved, the wound is irrigated, and the lung is inflated to detect any breaks in the pleural lining. If small air bubbles are observed during positive-pressure ventilation or if the irrigation fluid appears to be lost into the pleural space, a small chest tube may be placed through a separate wound. The incisional wound is closed in two layers after placement of a small closed-suction drain in the operative field.

Supraclavicular Approach

Anesthesia and positioning

After induction of general anesthesia, the patient is positioned supine with the head of the bed elevated 30 degrees. The hips and knees are flexed, and the neck is extended and turned to the opposite side. The neck, upper chest, and upper extremity are prepared into the field with the arm wrapped in a stockinette, then held comfortably across the abdomen. This positioning allows for arm movement through an extended range of motion during the operation, when it may be necessary to assess any residual neurovascular compression after scalenectomy.

supraclavicular approach: surgical anatomy



Incision and approach

A transverse skin incision is made two fingerbreadths above the clavicle, beginning at the lateral border of the sternocleidomastoid muscle. This incision is carried through the platysma muscle layer to expose the scalene fat pad. Several supraclavicular cutaneous nerves cross the operative field in this region. Division of these sensory nerves results in postoperative numbness and dysesthesia below the clavicle, but division of these small cutaneous branches, when necessary, does not appear to produce significant problems

Operative procedure

The scalene fat pad is mobilized beginning at the lateral edge of the internal jugular vein. As this tissue plane is entered, the fat pad is progressively dissected off the anterior surface of the anterior scalene muscle and reflected laterally. The phrenic nerve is identified within the investing fascia of the muscle, coursing in a superolateral to inferomedial direction. The inferior and superior attachments of the scalene fat pad are divided between ligatures to allow full exposure of the anterior scalene muscle. Lateral retraction of the scalene fat pad then permits exposure of the underlying roots of the brachial plexus.

The anterior scalene muscle is dissected, with special effort made to avoid excessive traction on the phrenic nerve. The C5 and C6 roots of the brachial plexus and the subclavian artery are observed at the lateral edge of the anterior scalene, with care taken to avoid injury to these structures during mobilization of the anterior scalene muscle. The proximal subclavian artery must also be well visualized and protected at the medial edge of the muscle. After circumferential mobilization of the anterior scalene muscle to its site of attachment to the first rib, a finger or right-angled clamp is passed behind the muscle, and the muscle tendon is sharply divided from the edge of its insertion. This division is made under direct vision and with a curved scissors rather than the cautery. Additional slips of muscle or tendon must be divided more posteriorly, including direct attachments of the muscle to the thickened pleural lining behind the rib itself.

The muscle is lifted superiorly to detach it from the additional structures underneath, including the pleural apex, the subclavian artery, and the brachial plexus nerve roots. This dissection is carried superiorly to the level of the scalene muscle origin on the transverse process of the sixth cervical vertebra. Great care must be taken to avoid neural injury during removal of muscle fibers interdigitating with the proximal roots of the upper brachial plexus. The entire anterior scalene muscle is then removed and sent to the neuromuscular pathology laboratory.

After anterior scalenectomy and removal of any scalene minimus muscle fibers, each of the nerve roots contributing to the brachial plexus is identified and dissected free of inflammatory scar tissue. Moderately dense fibrotic tissue encasing the nerve roots is not uncommon in patients with neurogenic TOS; because this scar tissue may contribute to nerve root compression, irritation, and neurogenic symptoms, failure to perform an adequate neurolysis may be one cause of persistent symptoms. During the course of this dissection, it is also important to ensure full mobility of the upper aspect of roots C5 and C6, which might remain entrapped by any residual scalene muscle or other fibrous tissue at the apex of the scalene triangle. Similarly, the origin of the T1 nerve root may be compressed by the posterior neck of the first rib. Relief of this source of nerve compression requires adequate visualization of the proximal first rib to effect complete nerve root mobility. This aspect of the operation is not complete until each nerve root from C5 to T1 is completely dissected throughout its course.

Osseous cervical ribs or their soft tissue counterparts occur within the same plane as the middle scalene muscle. Although the middle scalene muscle lies posterior to the roots of the brachial plexus, in some cases its insertion upon the first rib may occur as far anteriorly as the scalene tubercle (the site of attachment of the anterior scalene muscle). The composition of the middle scalene muscle may also be firm and tendinous in this region, thereby serving as another potential source of nerve root compression or irritation. The attachment of the middle scalene muscle is divided from the first rib with a periosteal elevator or curved Mayo scissors, with the division extending to a point posterior to the brachial plexus nerve roots. If a cervical rib is present in the plane of the middle scalene muscle, it may also be detached from the first rib at this time. It is important to note the separation between the middle scalene and posterior scalene muscles, as defined by the oblique course of the long thoracic nerve. Muscle tissue anterior to this nerve is detached along the plane delineated by the nerve, which is left intact. In order to avoid motor dysfunction of scapular apposition to the chest wall, it is also important to recognize that the long thoracic nerve may be represented by two or three branches at this level, rather than a single nerve as often described.

After resection of the anterior and middle scalene muscles and completion of a thorough brachial plexus neurolysis, an intraoperative decision is made regarding the potential role of the first rib in neurovascular compression. The surgeon’s finger is placed alongside the subclavian artery and brachial plexus nerve roots while the arm is elevated through a normal range of motion at the shoulder, allowing the surgeon to readily detect any residual compression during arm elevation. In many patients with neurogenic TOS, there is little residual compression by the first rib after adequate scalenectomy, and in these cases, retention of the first rib is considered. In contrast, the first rib is removed if it contributes to residual neurovascular compression as well as in all patients with arterial or venous TOS.

First rib resection is readily accomplished through the supraclavicular approach, given the exposure already achieved at this stage of the operation. With use of a periosteal elevator, any remaining muscle fibers of the middle scalene muscle are detached from their insertion on the top of the posterior first rib. This dissection is always performed under direct vision to protect the C8 and T1 nerve roots. Using a fingertip covered with gauze, the surgeon bluntly dissects the pleural membrane away from the inferior aspect of the first rib. Intercostal muscle attachments to the first rib are divided with a periosteal elevator, to relieve the posterior and lateral aspects of the first rib of all soft tissue attachments, and any remaining intercostal attachments are divided along the anterolateral aspect of the rib up to the scalene tubercle. The brachial plexus nerve roots are displaced anteriorly to expose the posterior neck of the rib.

While the assistant protects the nerve roots with a fingertip, the surgeon inserts a rib cutter over the neck of the isolated first rib and applies it. A bone rongeur is used to resect additional amounts of bone as needed to ensure that the end of the rib will not impinge upon the lower nerve roots and to create a smooth surface on the posterior stump of the first rib. The proximal portion of the rib is displaced inferiorly to open the anterior costoclavicular space, and a bone cutter is inserted at a level immediately medial to the scalene tubercle to divide the proximal rib. The first rib is then extracted from the operative field and discarded, and the proximal end of the rib is remodeled to a smooth surface with a bone rongeur. In rare situations in which the first rib is particularly enlarged and cannot be removed through the supraclavicular exposure alone, a second transaxillary incision may be employed to accomplish this step in the procedure.

Upon completion of the operation, several sheets of a bioresorbable hyaluronidate membrane can be placed within the wound to limit the potential for postoperative scarring. One sheet is placed posterior to the brachial plexus nerve roots, a second is used to wrap individual nerve roots, and a third is placed anteriorly, between the surface of the brachial plexus and the scalene fat pad. A closed-suction drain is placed into the supraclavicular field, and the scalene fat pad is reapproximated over the brachial plexus before the wound is closed.

Cervical Sympathectomy

Indication

Patients with disabling neurogenic TOS may at times present with sympathetic overactivity resulting in painful vasospasm, delayed healing of digital skin lesions, and reflex sympathetic dystrophy. In these situations the primary procedure done for thoracic outlet decompression can be accompanied by cervical sympathectomy. This step adds substantial benefit with respect to alleviating vasospastic complaints or facilitating the healing of digital lesions.

Operative methods

The surgeon first identifies the cervical sympathetic chain through the supraclavicular wound by palpation, finding a rubber band-like structure passing vertically over the neck of the first or second rib. The sympathetic chain is elevated with a vagotomy nerve hook and mobilized to the level of the third rib through sharp division of its lateral rami. The stellate ganglion is also identified just above the level of the first rib. After placement of metal clips at each end of the sympathetic chain, it is divided sharply and removed; in order to reduce the incidence of Horner's syndrome, the proximal extent of sympathetic resection is marked by the lower half of the stellate ganglion.

Postoperative Management

Chest x-ray is done postoperatively to detect residual pneumothorax or pleural fluid, which may be present in up to 10% of patients. Small air or fluid collections are carefully observed with the expectation of spontaneous resolution; although transthoracic aspiration may be necessary for a large or expanding pneumothorax.

Postoperative pain medication is provided by intravenous opioids until adequate control can be achieved by oral medications: these may be needed for at least 2 weeks after surgery. The closed-suction drain is removed 3 days after surgery unless there is persistent lymphatic fluid present, in which case the patient is discharged with the drain in place, and the drain is removed once the leak has subsided.

Patients are advised to avoid excessive reaching overhead and heavy lifting. Physical therapy is resumed in the first postoperative week. Patients are cautioned against activities that can result in muscle strain, spasm, and significant pain in the trapezius and other neck muscles, and a gradual return to use of the upper extremity is encouraged. Return to light-duty work by 4 to 6 weeks is allowed with advise to avoid excessive use of the upper extremity by lifting or repetitive activities that may contribute to postoperative complaints. Physical therapy is continued for as long as necessary to allow the patient to return to an optimal level of function. The patient is then seen at least yearly to assess the long-term results of operative intervention.

Surgical Complications

Nerve Injuries

Injuries to the brachial plexus nerve roots

Injuries can occur through both direct and indirect mechanisms; limited exposure during transaxillary exposure can leave the upper nerve roots susceptible, and traction on the brachial plexus during retraction can also injure the nerve roots in a manner not recognized until after operation.

These factors are reduced in procedures performed through the supraclavicular route because of the improved exposure of the nerve roots, but brachial plexus palsies can still occur secondary to retraction. In the absence of direct injury, however, these complications are temporary and will resolve within weeks to months of the operation.

Phrenic nerve dysfunction

This is relatively common after supraclavicular thoracic outlet decompression, occurring in approximately 10% of patients. This complication is most often associated with retraction of the nerve necessary to accomplish anterior scalenectomy and results in temporary diaphragmatic paralysis.

The patient may be asymptomatic given adequate compensation by the contralateral diaphragm, and diagnosis may require chest fluoroscopy. Some may have respiratory difficulty with extremes of exertion but patients with underlying lung disease before surgery may have more significant symptoms.

These resolve with recovery of phrenic nerve and diaphragmatic function within weeks , full recovery may take up to 10 months.

In patients with bilateral TOS requiring operation on the contralateral side, it is essential to ensure that any phrenic nerve paresis has completely resolved before the second operation is performed. Complete diaphragmatic paralysis leads to severe ventilatory incapacity.

Lymph Leakage

This occurs due to lymph fluid leakage from small tributaries subjected to higher fluid pressures than normal and is a common complication. These resolve spontaneously within weeks. It may require a secondary procedure if it fails to do so.

Results of Surgery

Outcome Measures

Thoracic outlet decompression for the treatment of neurogenic TOS is intended to provide functional relief of preoperative upper extremity symptoms that have been refractory to conservative management. Assessment of results therefore depends on functional evaluation of symptoms and the patient's subjective perception.

The rate of good outcomes for transaxillary first rib resection has ranged from 37% to 100% (mean 80%), with fair outcomes in 0 to 14% (mean 6%) and failure of operation in 0 to 41% (mean 15%) [14-20].

The results for supraclavicular decompression were good in 59% to 91% of cases (mean 77%), fair in 5% to 33% (mean 15%), and poor in 3% to 18% (mean 8%). These results are from seven different publications involving a total of 1222 patients, the largest being the series reported by Hempel and colleagues (770 operations) [21-27].

Adjunctive procedures during surgery

Arterial Repair

Removing an embolic source usually is done by resection and interposition graft replacement, although segmental resection with reanastomosis or patch closure of a partial resection may be possible with small focal lesions. Often the artery appears normal externally, but after opening it, an ulcerated intimal lesion is identified.

Distal Revascularization

In the setting of acute ischemia, endovascular techniques for revascularization may be attempted and include regional thrombolytic therapy, mechanical thromboembolectomy, and balloon thromboembolectomy. When symptoms are more chronic, distal bypass is often required because these young patients may experience more disability from exercise-induced ischemia. Standard bypass techniques use subclavian or common carotid artery inflow, saphenous vein as the preferred conduit, and tunneling that minimizes traction and compression during arm movement.

The distal target artery is selected by size, runoff to the palmar arches, and access through a familiar dissection. When there is occlusion of the radial and ulnar arteries, an interosseous artery anastomosis is chosen. This uncommon exposure requires determination of the dominant patent anterior or posterior branch on an oblique arteriogram. The anterior interosseous artery is accessed between the flexor digitorum profundus and flexor pollicis longus muscles, and the posterior branch is exposed through incision on the dorsum of the forearm.

Upper extremity arteries are often more fragile and prone to spasm, which may be treated with topical papaverine [3]. Completion arteriography or Doppler evaluation is performed frequently before closing. Long-term outcomes are excellent after distal vein bypass for thoracic outlet syndrome.

For cases of chronic digital vessel occlusion, when a distal bypass is not indicated or when it is not possible, alternative therapies are considered. These include long-term anticoagulation, protection from cold, prostaglandin infusion, and sympathectomy.

Recurrent Thoracic Outlet Syndrome

Published rates of recurrence for thoracic outlet syndrome range from 2% to 20%. Recurrence most often occurs in patients presenting initially with neurogenic symptoms when it is sometimes unclear whether patients ever manifested any improvement postoperatively. Long posterior first rib stumps, missed cervical ribs, incomplete scalene resection and scar formation are other causes.

The workup and initial treatment for recurrent TOS are the same as the initial workup of previously undiagnosed disease. Other disease processes such as carpel tunnel syndrome, cervical arthritis, and tendonitis have to be ruled out [28].

Initial treatment is conservative: treatment may be far less successful when symptoms are recurrent.

Operative approach the postsurgical thoracic outlet can be using the same or a new incision. The first step is to identify the anatomy and any residual muscle or fibrous bands that need to be resected. First rib resection(if not done at index operation) and neurolysis are also performed.

Venous TOS

Sir James Paget in 1875 described acute pain and swelling of the arm. Von Schroetter in 1884 was first to correlate the clinical syndrome to thrombotic occlusion of the subclavian vein and axillary veins.

Axillosubclavian vein thrombosis (ASVT) accounts for about 3% The management is staged and multimodal. Treatment requires restoration of luminal patency and removal of any extrinsic compression.

Catheter -directed thrombolysis is the treatment of choice. Patients treated within a few days of onset have a better response rate than patients treated within a few weeks. The likelihood of success is a function of the time from thrombosis to the initiation of treatment.

When the lesion is intrinsic the treatment and the timing are controversial. Options include anticoagulation, antiplatelets and delayed outlet decompression depending on the level of symptoms, outlet decompression with external venolysis, outlet decompression followed by angioplasty and stenting. Regular follow up is essential [3,28]

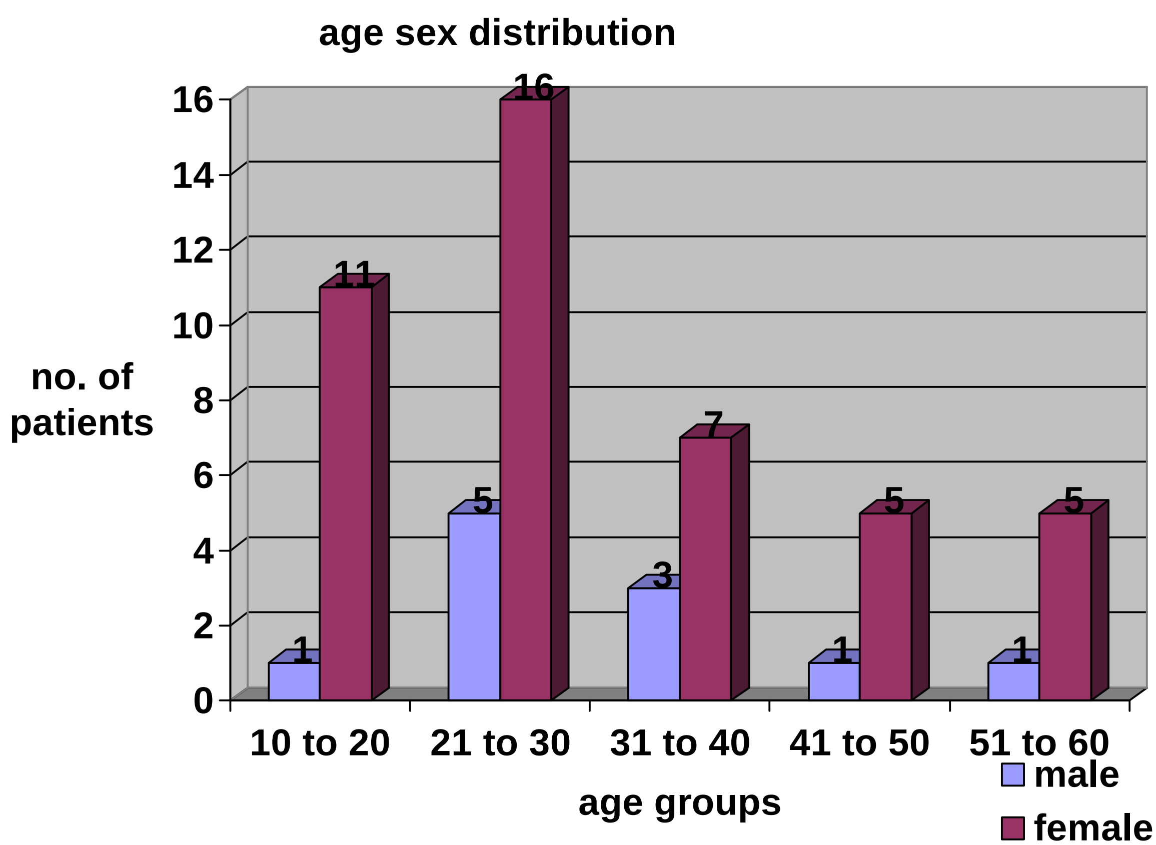
Materials and methods

This is a retrospective study conducted in the department of general and vascular surgery, Christian medical college, Vellore. The case records of patients with a clinical diagnosis of thoracic outlet syndrome who underwent surgery over a 12 year period from 1995 to 2007 were reviewed. Demographic detail, presenting symptoms, investigation modalities, surgical approach, operative details and complications were gathered from inpatient and outpatient records. The available information was enetered in a Excel database and analysed.

The institutional review board of the Christian Medical College, Vellore reviewed and approved the study, IRB Min. No. 6699.

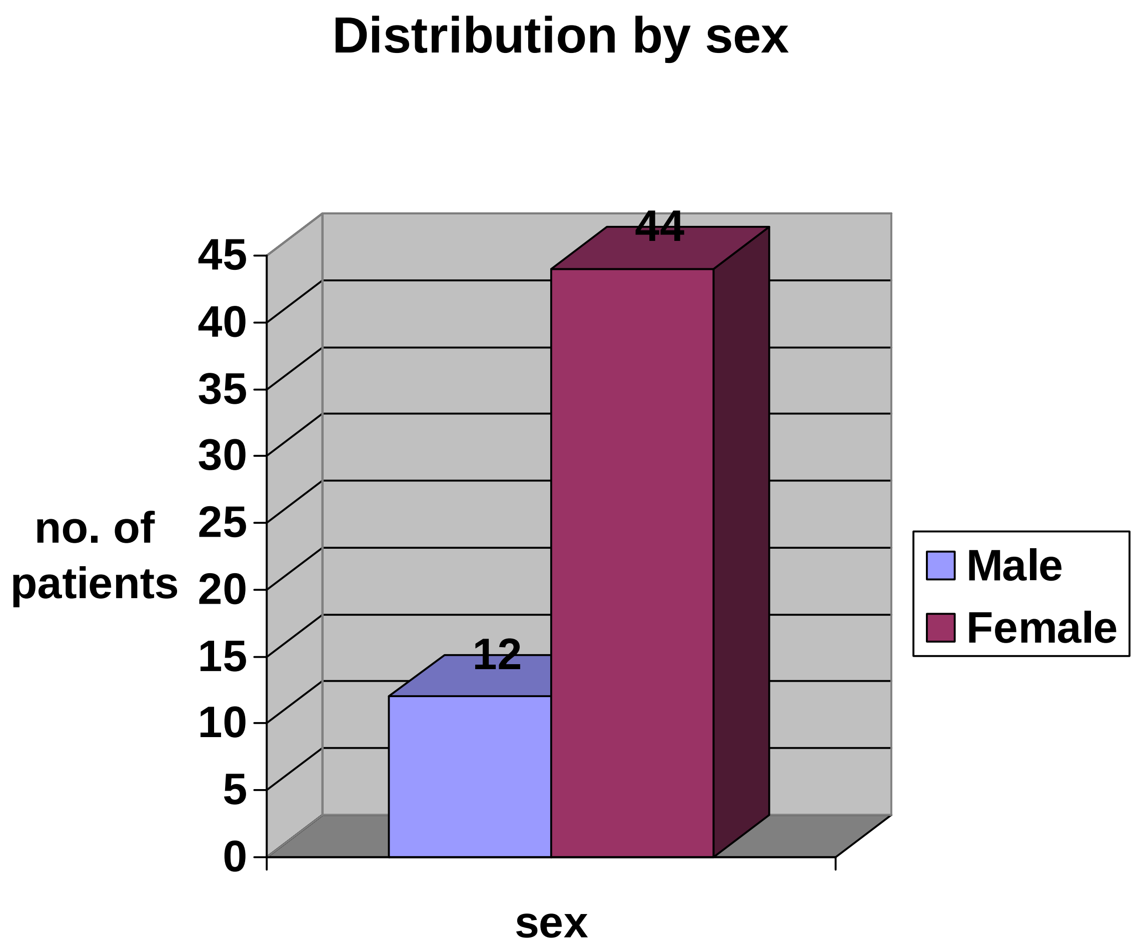
Results

A total of 56 patients underwent 60 operations. Four patients underwent bilateral surgery.

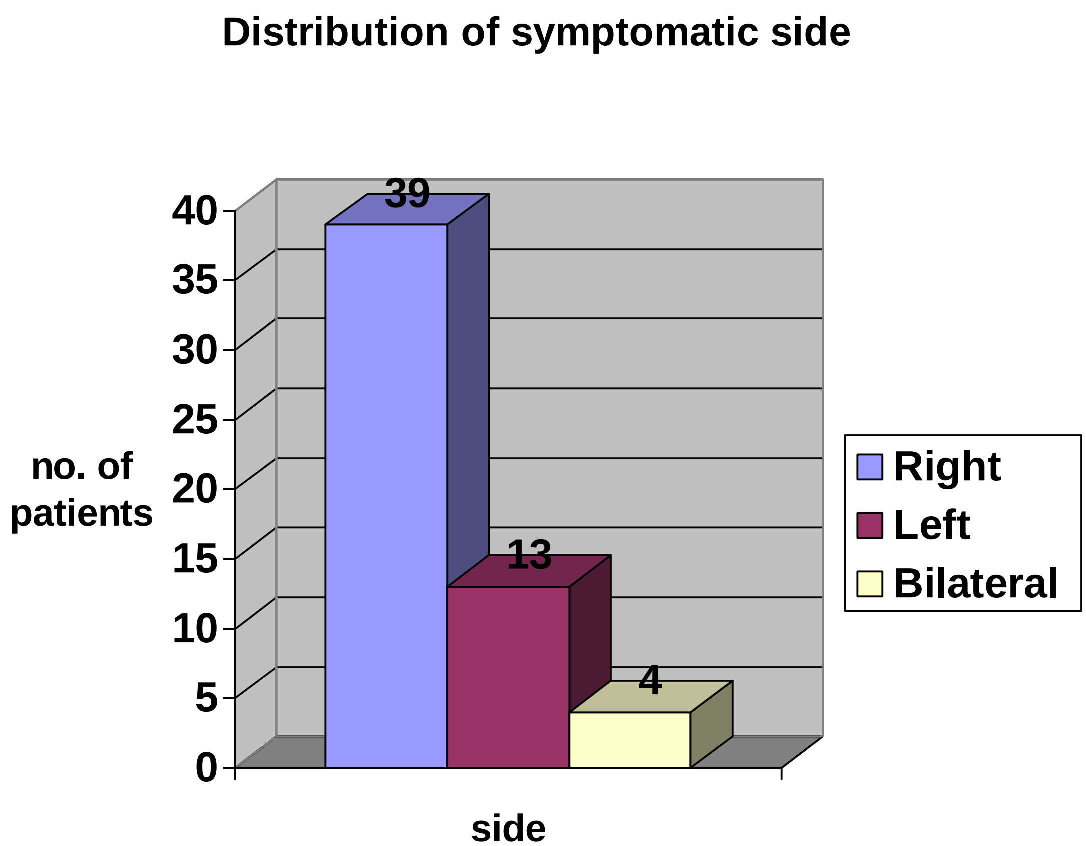


The mean age at presentation was 30.3 years (range 10-56 years).

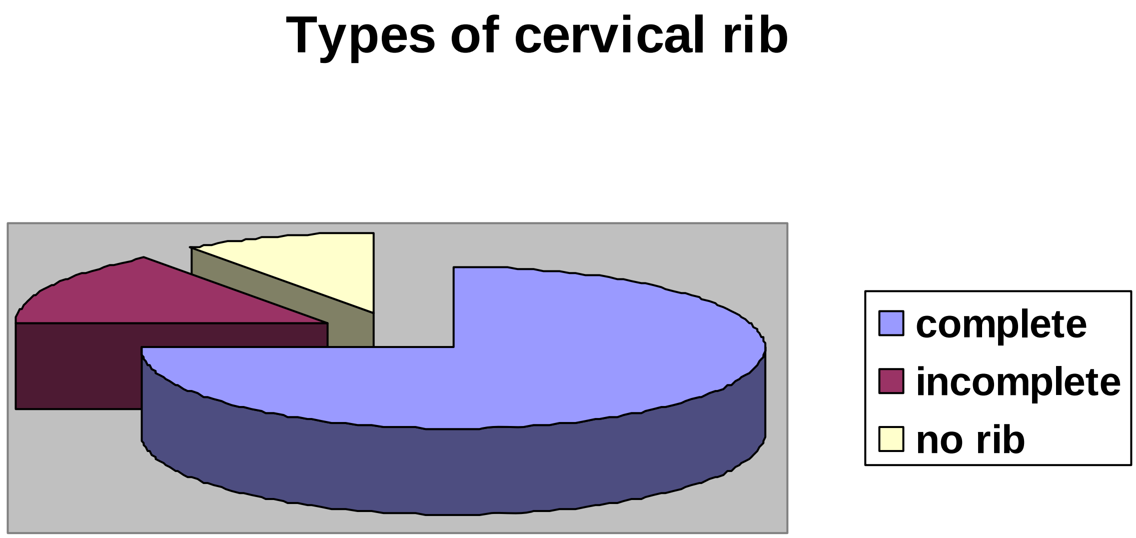
The syndrome was found to be four times more common in females (male: female = 12:44).



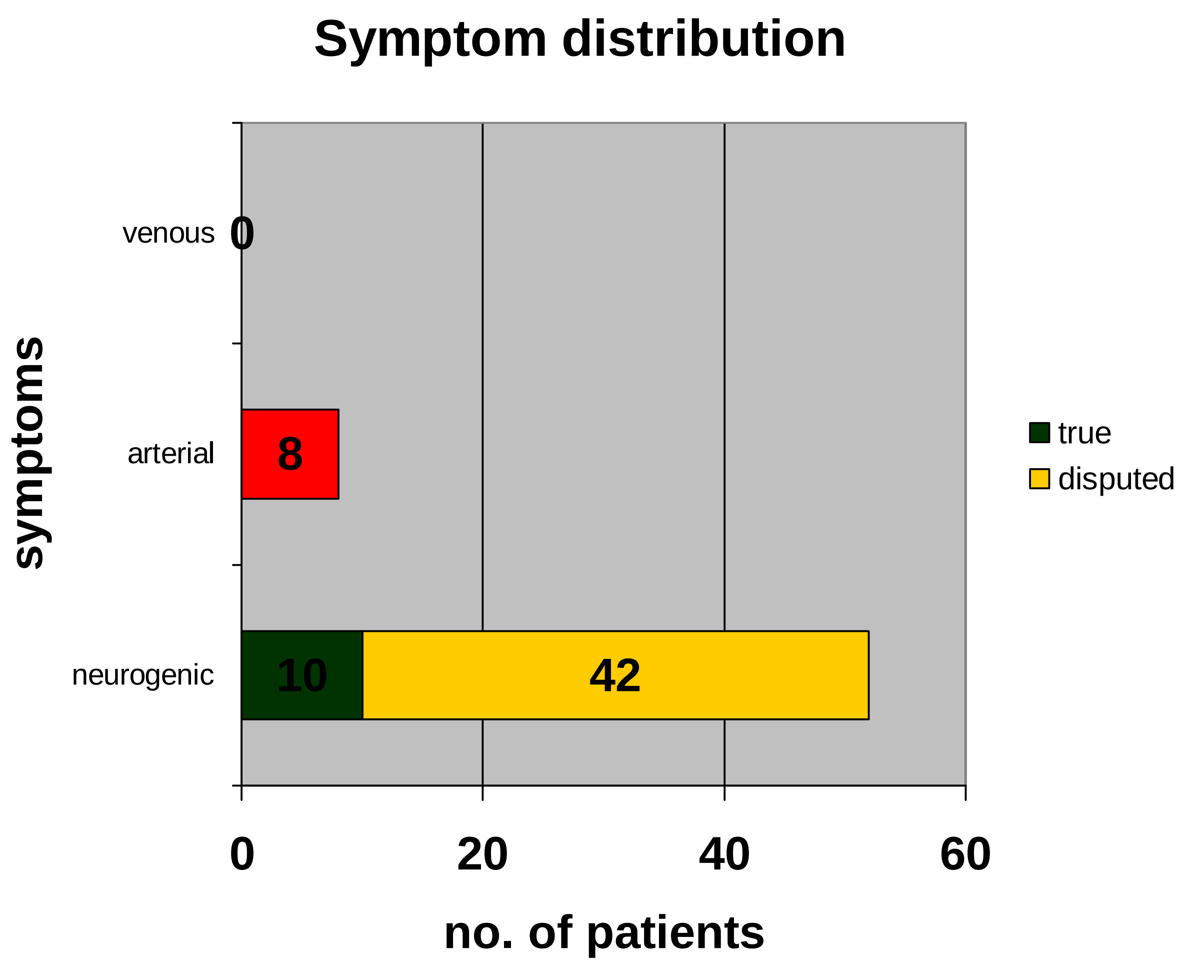
Symptoms were more common on the right side (right: left: bilateral = 39: 13:4).



Cervical rib was present in 54 cases of which complete cervical ribs were 45 and incomplete rib 9. Only six patients did not have a cervical rib.

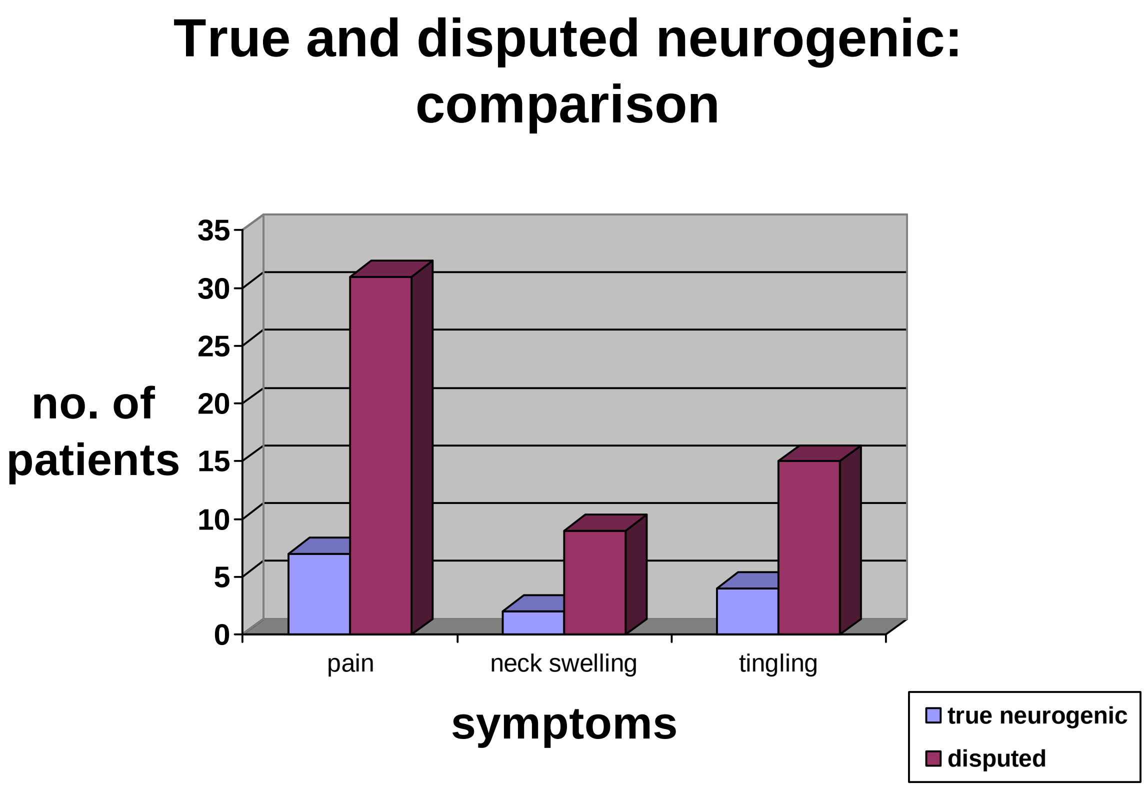


Based on the predominant symptoms patients were grouped into three categories, neurogenic, arterial and Venous. Fifty two patients had neurogenic, 8 had vascular and none had venous presentation. The neurogenic were further classified as true or disputed based on the presence or absence of clinical signs.



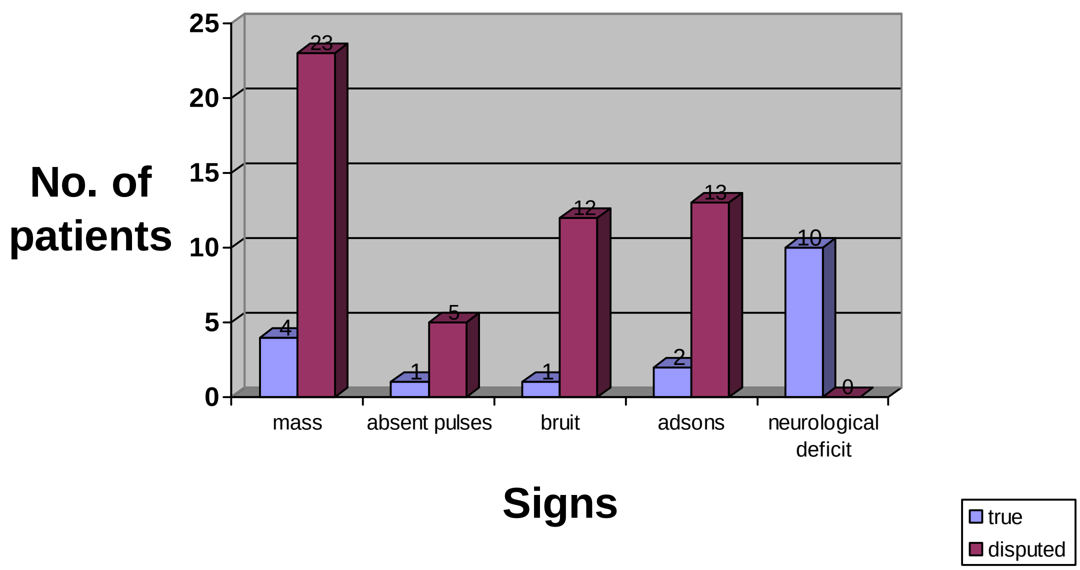
NEUROGENIC TOS

Symptoms at presentation were, pain, neck swelling and tingling.

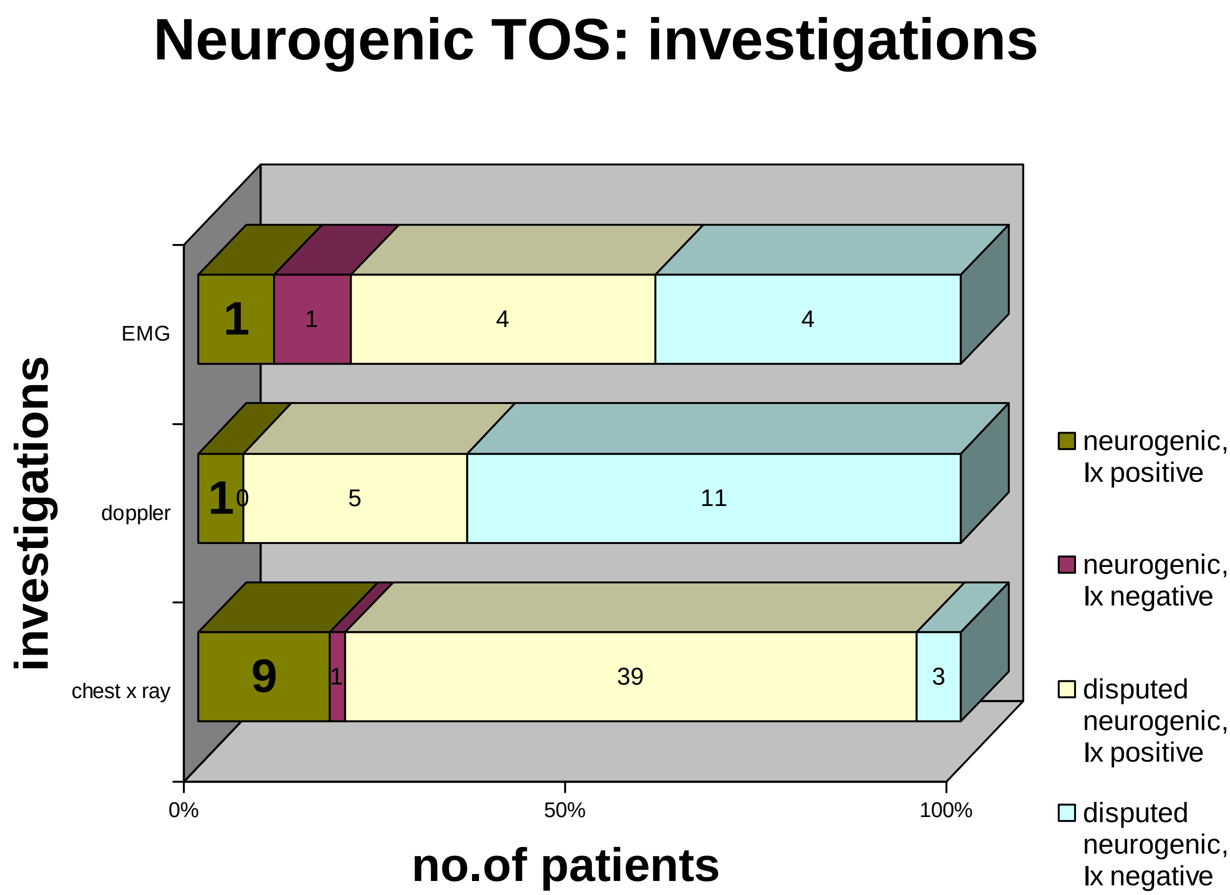


As observed in the graph the true neurogenic group had tingling as the common presenting symptom, whereas pain was the common symptom in the disputed group.

True and disputed neurogenic: comparison

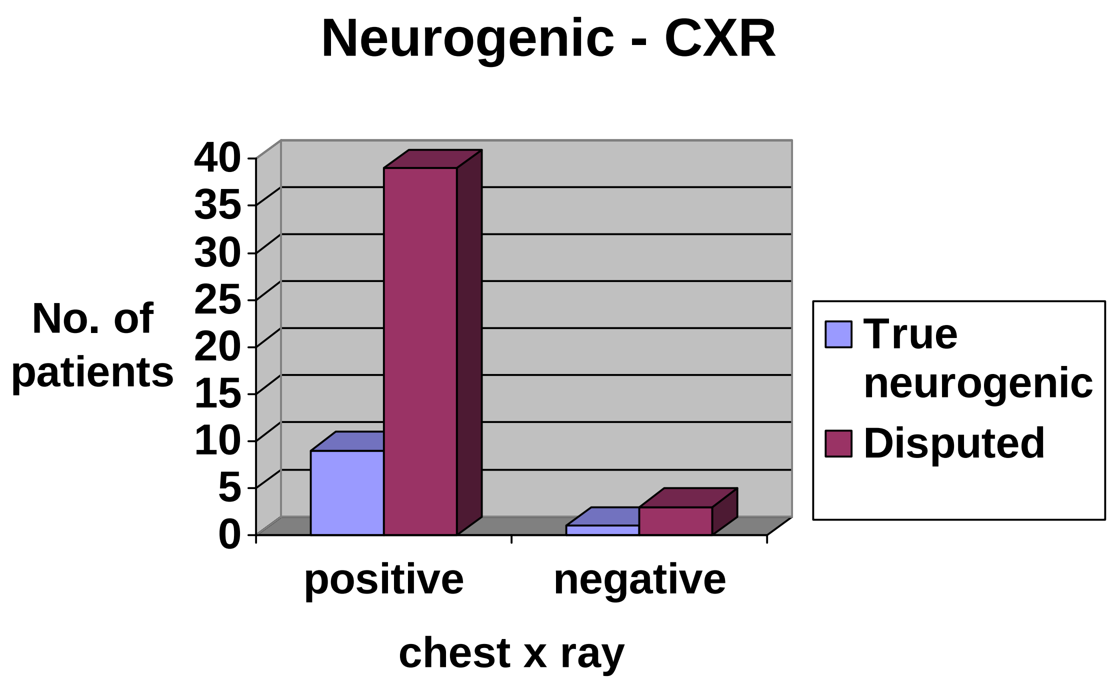


In the true neurogenic group as per grouping criteria the neurological deficits was the commonest sign and a palpable neck mass was commonest in the disputed group.

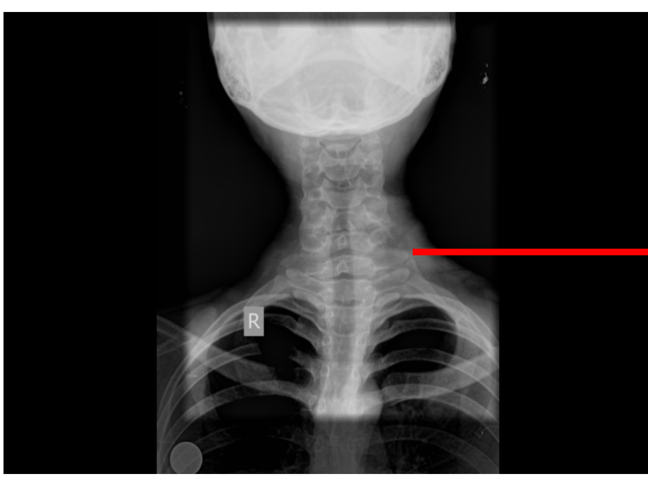


In the above graph it could be observed that only 19% of the disputed group had an electrophysiologic study, of which only 50% was positive.

Chest X-ray was done in all patients.

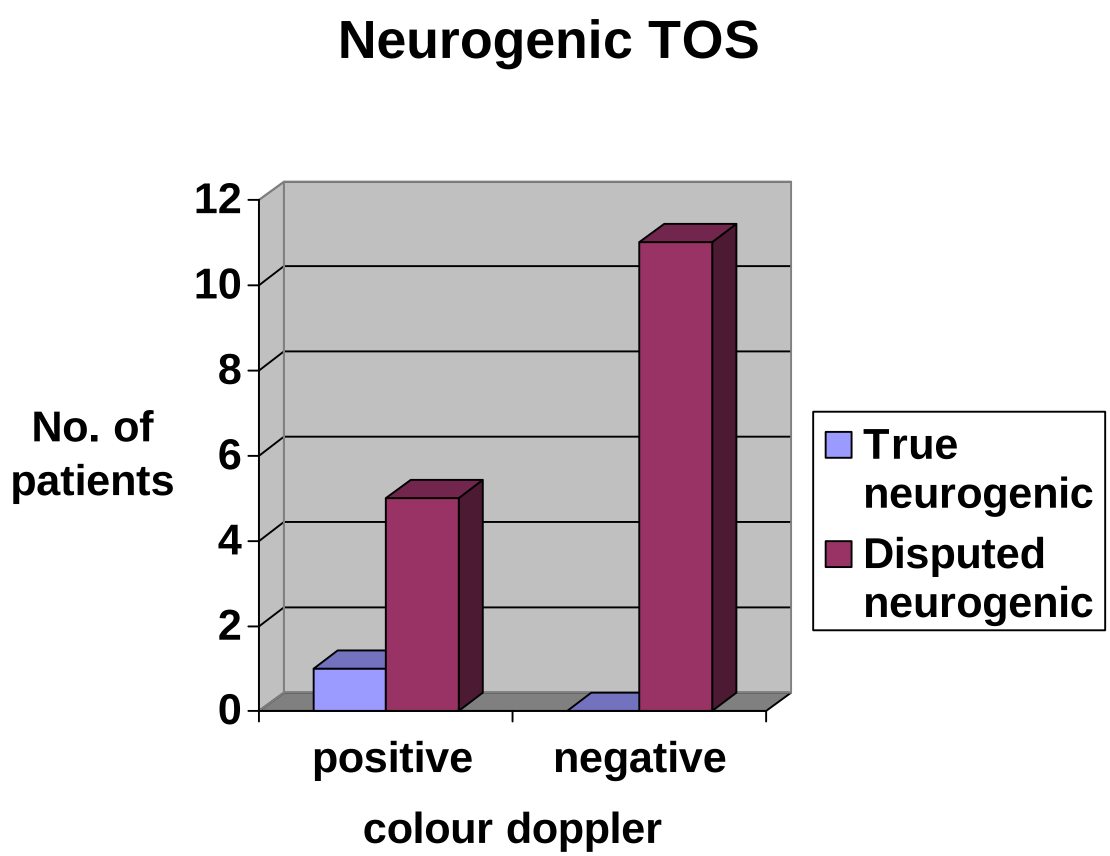


In true neurogenic group chest roentgenogram was 90% positive and in the disputed group it was 92.8% positive.

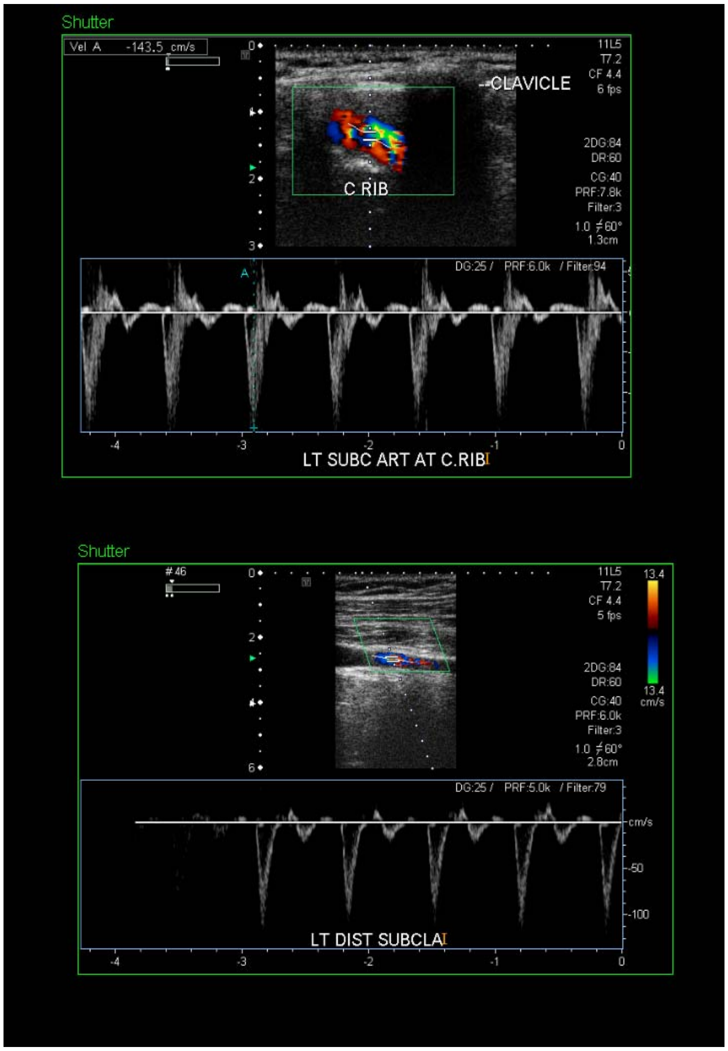


cervical rib

Colour Doppler(CD), was done in 17 patients.

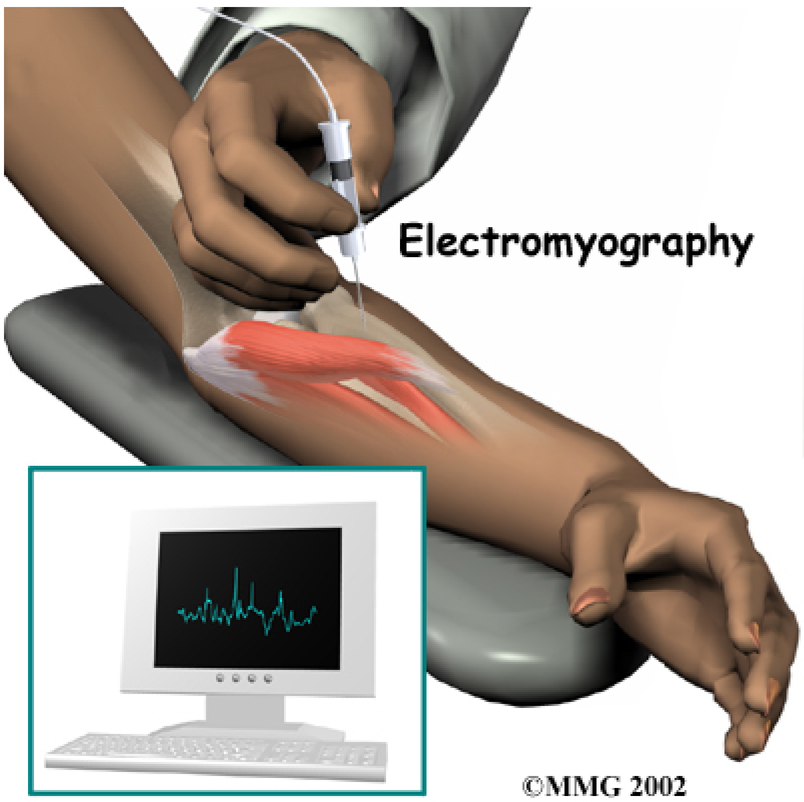


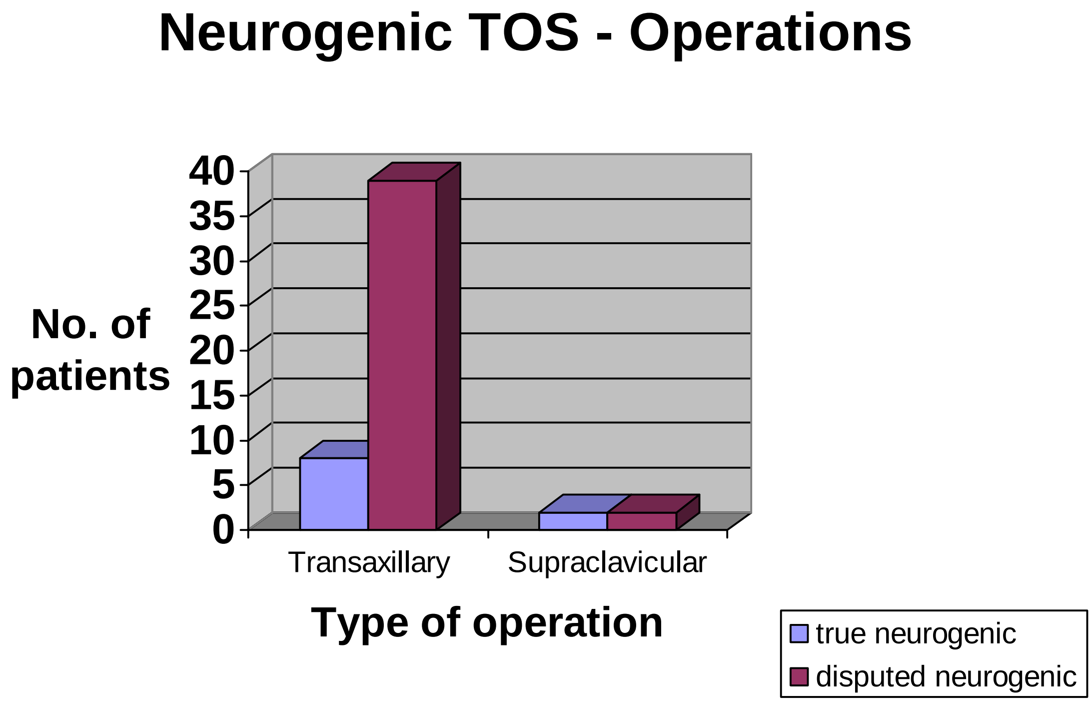
Doppler features of TOS were turbulence at the level of the cervical rib with decreased flow beyond. The following are representative images of one of the patients.



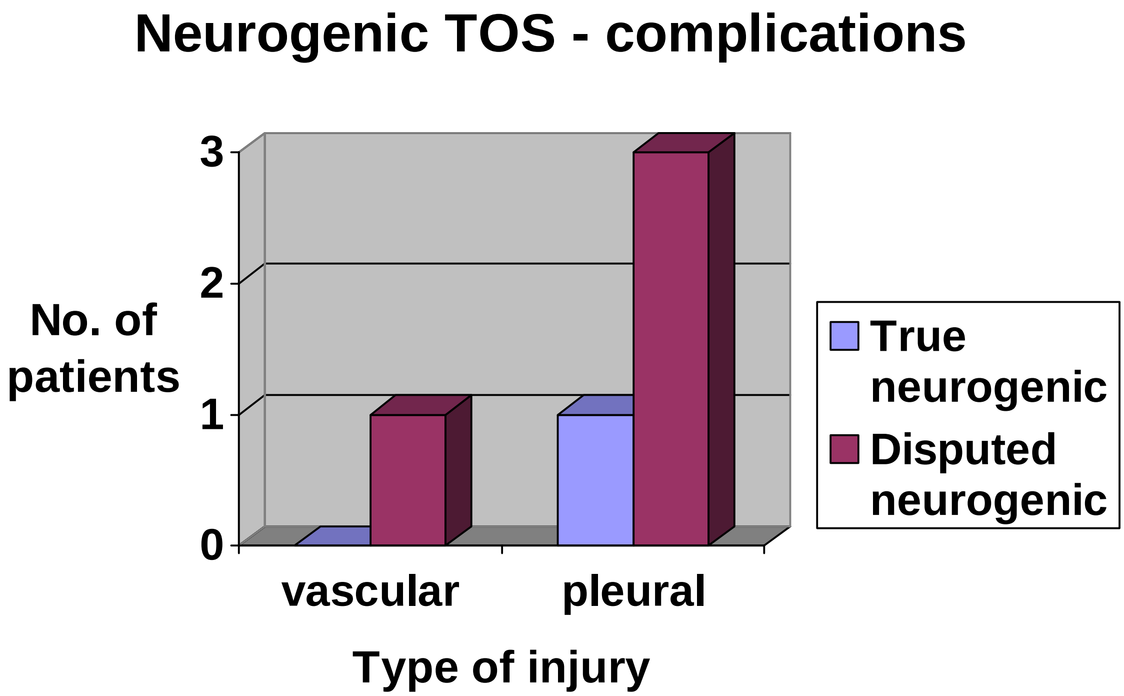
Nerve conduction study was done in totally 10 patients and was abnormal in 5.

In the disputed neurogenic group 4 had positive and 4 had negative.



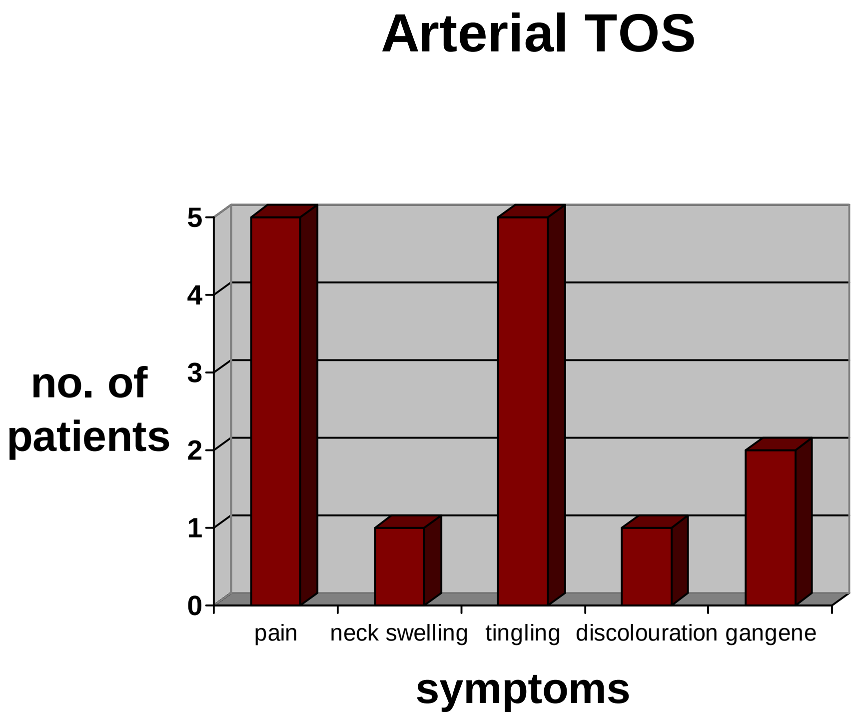


As seen in the graph most patients had a transaxillary approach. Four patients who had a supraclavicular approach had scalenectomy done.

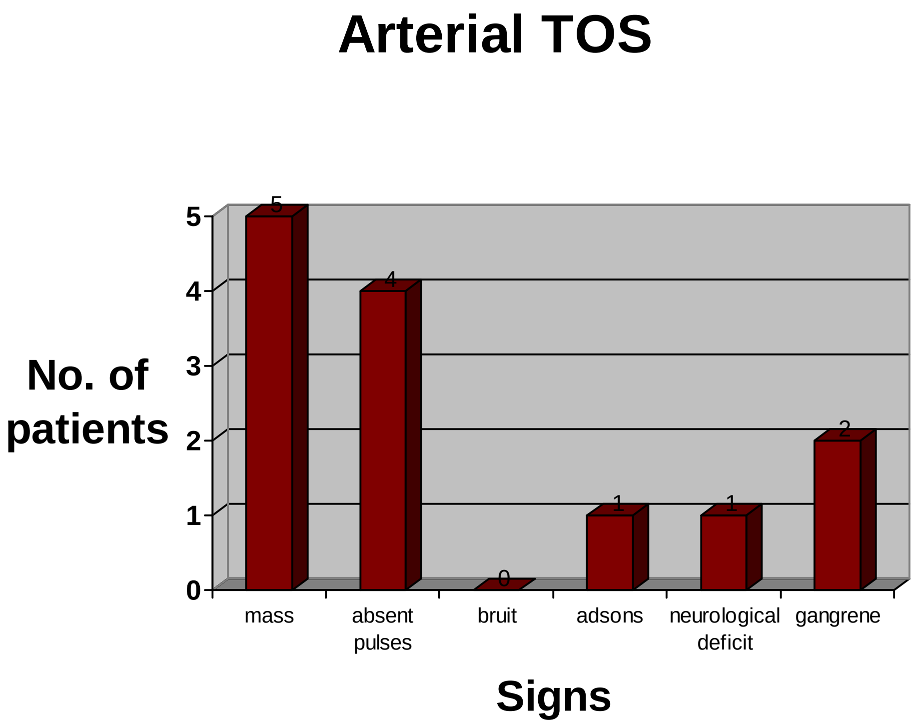


The vascular injury was an axillary vein tear which was repaired primarily and the patient had an uneventful post operative period. The operative complications included pneumothorax in 4 patients, which was treated by insertion of chest drain. Infant feeding tube drain was inserted intraoperatively in 1 patient and Pleural tear was sutured in 2 patients, minimal pleural effusion in 2 patients, with all of them having an uneventful post operative period.

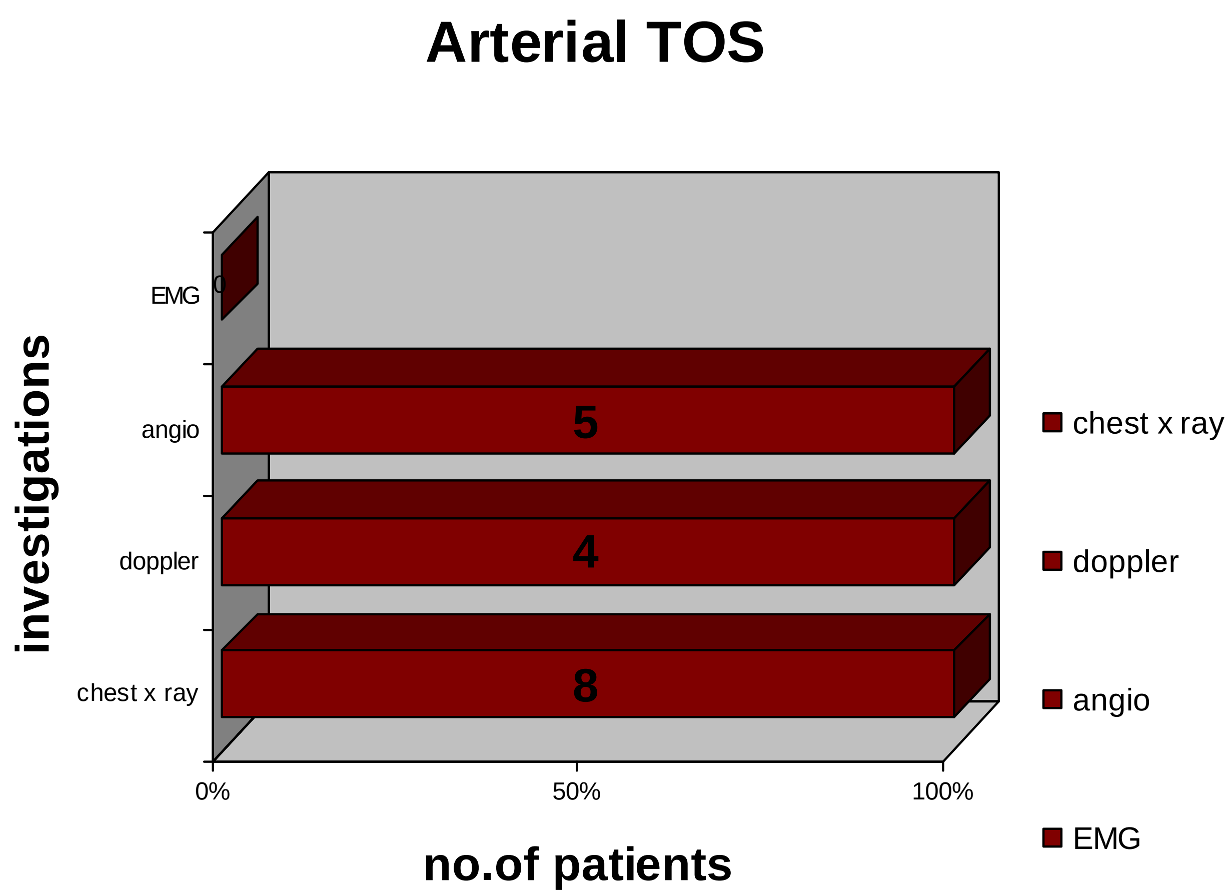
At 3 months following surgery, only 8 patients had come for follow up they had minimal symptoms.



Symptom distribution is similar to neurogenic TOS.



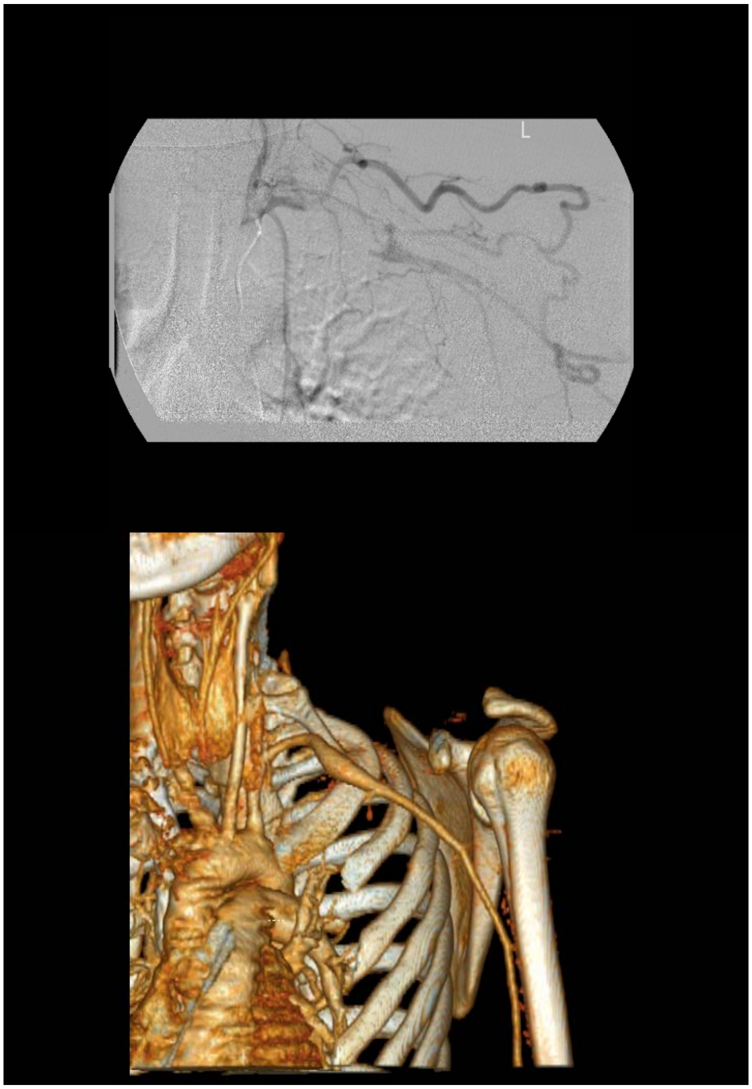
Distribution of signs as represented in the chart shows absent pulses to be commoner in the arterial TOS group as expected.



Angiogram showed stenotic lesion in the 5 patients. However aneurysms were not detected. It was thus accurate in detecting presence of arterial pathology but did not show the exact nature of involvement.

The use of CT reconstruction of images was useful to detect the post stenotic dilatation and this is an important advance in imaging of these lesions.

Few angio images and a CT reconstruction demonstrating this is shown in the following images.

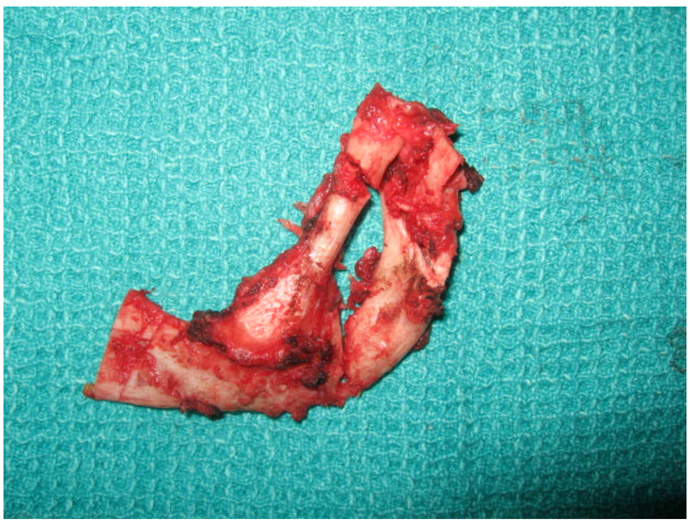


Surgical decompression of the thoracic outlet was done by a supraclavicular approach, as intraoperative assessment of the subclavian vessels was planned. These 8 patients had clinical or radiological features of vascular involvement In these 5 patients had subclavian artery thrombosis and three had aneurysms.

All patients with vascular pathology had a complete cervical rib.

Transcervical excision of cervical rib and first rib was accompanied by exploration of left subclavian and brachial artery in three patients. Subclavian artery aneurysm excision and end to end anastomosis was done in one patient, subclavio-axillary bypass was done in 4 patients, with thrombolysis brachial artery as an adjunct in one patient. Subclavian axillary bypass done using PTFE graft in 2 patients and vein graft in 2.

surgical specimen showing the cervical and first rib



There were no complications in the arterial group.

At 3 months following surgery, only 1 patient had come and was well in terms of objective signs like palpable distal pulses and symptomatic relief.

Discussion

Thoracic outlet compression was seen in a predominantly young population. There was a female predominance. This is similar to a Western population. The hospital based incidence of this condition has not shown any increase over the period of study.

Most patients presented with pain and neck swelling as the initial symptoms. At onset determination of the underlying cause; i.e. neurogenic, arterial or venous is important for further management. Patients with venous TOS have characteristic symptoms and clinical diagnosis is not difficult: however we did not have any such patients in our study period.

In patients with arterial TOS, vascular involvement due to the cervical rib was obvious due to presence of symptoms and signs like absent pulses or gangrene. The positive yield of investigations was higher in the arterial group, this could be attributed to the more tailored investigations in this group, as the symptoms were easily recognizable at presentation. They had clearly demonstrable flow abnormalities on Doppler and angiogram. They were planned for operation using a supraclavicular approach as vascular access was necessary.

Intraoperatively most of them had evidence of arterial involvement and they underwent repair as decribed above. Most patients had surgical bypass but one patient underwent thrombolysis and repair with a good surgical outcome.

True neurogenic TOS was found to be rare, with Cervical spine or chest radiographs usually showing a cervical rib or elongated C7 transverse Process. The treatment was also not controversial. However there was considerable problems defining and diagnosing disputed TOS, as found in the works of J.D.Urschel et al.

Use of EMG or imaging in patients with disputed neurogenic symptoms, as described in literature did not improve the diagnostic yield. Electrophysiological testing is not diagnostic in disputed neurogenic TOS as quoted by Wilbourn, A.J. & Lederman, R.J.

Because of the difficulties with electrophysiological diagnosis of disputed TOS, vascular assessment has been advocated as an indirect indicator of general neurovascular compression across the thoracic outlet, as published by J.D.Urschel et al.

It was found that no single investigation was helpful in diagnosing disputed neurogenc TOS except in the way of diagnosis by exclusion, as supported by Sadler et al.

The results of the present study confirm that transaxillary excision of the first rib is a surgical procedure associated with very low morbidity and good symptom relief, as published by Roos et al and Sanders et al. Supraclavicular approach is recommended if exposure of the subclavian artery is required for vascular reconstruction.

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Database code

History

0 : Asymptomatic
1 : Pain
2 : Neck swelling
3 : Tingling
4 : Bluish discoloration
5 : Gangrene

Examination

0 : No signs
1 : Palpable neck mass
2a: Absent pulse
2b: Bruit
3 : Adson’s positive
4 : Neurological deficits.
5 : Gangrene

Chest X ray

0 : No cervical rib
1 : Right cervical rib
2 : Left cervical rib
3 : Bilateral cervical rib

Colour Doppler

0 : Not done
1 : Done negative
2 : Done positive

Angiogram

0 : Not done

1 : Done negative
2 : Done positive

EMG
0 : Not done
1 : Done negative
2 : Done positive

Operation

0 : Transaxillary approach
1 : Supraclavicular approach

Complication

1 : Vascular injury
2a: Pleural injury
2b: Pleural effusion

Post operative period

E : Eventful
UE: Uneventful

Name	Patient ID	Age (yrs)	Sex	Side	History	Examination	CXR	Doppler
Neelavathyammal	546843B	50	F	L	4	2	2	0
Jeevarekha	407067B	40	F	L	1	3	2	0
Dr. Kanchana Bannur	352402B	26	F	L	1 & 3	2b	2	2
Selvi	451376B	36	F	R	1	0	1	0
Rituraj Banerjee	572897B	22	M	R	1	4	1	0
Shanthi	729364B	39	F	B/L	1 & 3	3 & 4	3	0
Ruby Isaac	623195B	18	F	R	2	1 & 2b	1	0
Bijula Rose	858707B	30	F	L	1	4	0	0
Lakshmi Mondal	534703B	26	F	R	2	1	1	0
Binadas Gupta	010892C	35	F	R	1	1	1	0
Sonali Roy	128910C	18	F	R	2	1 & 2b	1	0
Chitra Bhowal	204466C	28	F	L	2 & 3	1 & 2b	2	0
Raja	853007A	17	M	B/L	1 & 3	1 & 3	3	1
Karpagam	620183B	18	F	R	1 & 3	2b & 3	0	1
Archana Sarkar	139127C	31	F	L	1	0	1	0
Kanthi Ruby	553460B	40	F	B/L	3	1,2b	3	0
Kumari	393910B	27	F	R	1 & 3	1	1	2
Nangaiyar Thilagam	424589B	22	F	L	1	3	2	0
Nangaiyar Thilagam	424589B	21	F	R	1	3	3	0
Chhaya Chanda	582183B	39	F	R	1 & 3	0	1	1
Geena Varghese	724486B	23	F	R	1 & 3	1	3	0
Ruby Isaac	623195B	17	F	L	1 & 3	1,2b,3	3	0
Ranjana	635302B	19	F	L	1 & 3	1,3,4	3	0
Mousumi Karmakar	917731B	19	F	R	1 & 3	1	1	1
Dilip Kumar Shrivas	890398B	26	M	R	1	0	1	0
Grace Alice Singh	206136C	17	F	R	3	4	1	0
Saraswathy	337307	55	F	L	1 & 3	4	3	0
Dr. Smarajit Kumar Mondal	149374C	28	M	B/L	4	3	3	0
Suarti Patro	171541C	13	F	B/L	2	1,3	3	1
Susama Jana	188689C	20	F	R	1 & 3	0	3	0
Gowri Barury	214991C	55	F	L	1	1,2a	2	0
Gowthami	823144A	14	F	R	1	1,2b	0	1
Joya Dhar	652915C	10	F	R	2	1 & 3	1	0
Palani	656559C	53	M	R	1	1,2a & 2b	1	1
Madhumita Medda	464319C	30	F	B/L	1	1	3	2
Sulochana Devi	511187C	48	F	R	0	0	1	0
Indu Singh	240703C	49	F	L	3	0	2	0
Sangeetha	604038C	23	F	R	1	1,2b,3	1	2
Chhaya Devi	918765C	28	F	R	1,3	1	1	0
Soma Guha	960722C	21	F	R	1	0	1	0
Bijoy K.	963308C	30	M	R	1,2	1,4	3	0
Barnali Bhandari	863708C	28	F	L	1	1	3	0
Viji K.	906204C	22	F	R	1,2	1,2a	3	0
Pipasha Saha	819517C	22	F	B/L	1	1,4	1	1
Jagadeesan J	861134C	33	M	R	1,4	2a	0	1
Marzia Khan Orthy	873554C	14	F	B/L	1	1	3	0
Lakshmi V	441551C	20	F	L	2	1,2a,2b,4	2	2
Barun Halder	568445C	38	M	B/L	1,3	1,2a,3	3	1
Basante Sarkar	805310C	56	F	B/L	1,2,3	2b,3	3	0
Anjali Maity	815452C	30	F	B/L	1,2	1,2b,3	3	0
Farida Begum	713307C	32	F	R	1	0	0	1
Mageshwari	393489C	22	F	R	1	0	1	1

Angiogram	EMG	Year	Operation	Findings
0	0	1997	0	Complete cervical rib. Broad first rib
0	0	1996	0	Bony cervical rib.
0	0	1996	0	Complete cervical rib. Broad first rib
0	0	1997	0	Incomplete cervical. Broad first rib. Hypertrophied scalene anterior
0	0	1998	0	Complete cervical rib.
0	2	1999	1	No cervical rib
0	0	1999	0	Complete cervical rib
0	0	2000	1	incomplete cervical rib
0	0	2000	1	Bony cervical rib.
0	0	2001	0	Bony cervical rib.
0	1	2002	0	Complete cervical rib fusing with first rib
0	2	2002	0	Complete bony cervical
0	0	2002	0	Complete cervical rib. Broad first rib
0	2	1998	0	No cervical rib. Broad first rib
0	0	2002	0	broad fibrous band attached to first rib
0	2	1997	0	Incomplete cervical rib.
2	0	1996	0	Complete cervical rib.
0	0	1997	0	Complete cervical rib.
0	1	1996	0	Complete cervical rib.
0	0	1998	0	Complete cervical rib. Broad first rib
0	0	1999	0	No bony cervical rib
0	1	1998	0	Complete cervical rib.
0	1	1998	0	Complete bony cervical rib
0	1	2000	0	Complete cervical rib.
0	0	2000	1	Complete bony cervical rib
0	0	2002	0	incomplete cervical rib
0	0	2002	0	Complete cervical rib.
1	2	2002	0	incomplete cervical rib
0	0	2002	0	Complete cervical rib. Broad first rib
0	0	2002	0	Complete cervical rib.
2	0	2005	0	Complete cervical rib
0	0	2005	0	Broad first rib with fibrous band
0	0	2005	0	Complete cervical rib.
0	0	2005	0	Complete cervical rib. Prominent scalene tubercle broad first rib.
0	0	2004	0	Complete cervical rib.
0	0	2005	0	Cervical rib broad first rib.
0	0	2005	0	Incomplete cervical rib.
0	0	2005	0	Complete cervical rib with knob like end. Broad first rib.
0	0	2007	0	Complete cervical rib.
0	0	2007	0	Broad first rib. Incomplete cervical rib
0	0	2007	0	Complete cervical rib.
0	0	2006	0	Incomplete cervical rib. Broad first rib. Brachial chord adherent to cervical rib.
0	0	2006	0	Complete cervical rib.
0	0	2007	0	Complete cervical rib.
0	0	2006	0	Complete cervical rib. Broad first rib. Brachial chord adherent to cervical rib.
0	0	2006	0	Complete cervical rib.
0	0	2006	0	Complete cervical rib fused with first rib.
0	0	2005	0	Complete cervical rib. Broad first rib. Prominent scalene tubercle.
0	0	2006	0	Incomplete cervical rib.
0	0	2006	0	Complete cervical rib.
0	0	2006	0	No cervical rib
0	0	2004	0	Complete cervical rib with broad first rib.

Complication	Course	In Hospital Stay	Others	Follow Up
0	UE	16		
2b	UE	6		
0	UE	3		
0	UE	8		
0	UE	6		
0	UE	3		
0	UE	6		
0	UE	4		
0	UE	4		
0	UE	6		
1	UE	4		
0	UE	5		
0	UE	7		
2a	UE	7		
0	UE	4		
0	UE	8		
1&2a	E	29	Thrombolysis of axillary artery	
0	UE	6		
0	UE	11		
0	UE	7		
3	UE	12		
0	UE	7		
2a	UE	11		
0	UE	6		
0	UE	5		
0	UE	5		
0	UE	5		
2a	UE	3		
2a	UE	11		
0	UE	4		
0	UE	9		
0	UE	4		5 month. Min pain
0	UE	4		1 week. Well
0	UE	12	Anticoagulation	3 month. Well
2b	UE	3		1 month. well
0	UE	3		1 week. Wound infection
0	UE	4		
0	UE	3		0
0	UE	4		6 months. Non specific pain
0	UE	4		1 month. Well
0	UE	3		1 week. Well
0	UE	3		1 week. Well
0	UE	5		1 week. Well
0	UE	5		1 week. Well
0	UE	2		6 month.
0	UE	7		
2a	UE	6		1.5 year. Non specific pain
0	UE	4		1 week. Well
2a	UE	6		3 months . Well
0	UE	4		6 months. Well
0	UE	6		7 month. Well
0	UE	4		1 week. Well

Name	Patient ID	Age (yrs)	Sex	Side	History	Examination	CXR	Doppler
Kanthammal	469293B	50	F	R	0	0	1	0
Dilip Kumar Shrivas	890398B	26	M	B/L	1 & 5	1,2a, 4, 5	3	2
Reeta Devi	038385C	42	F	L	5	5	2	0
Ibne Ali	524627C	29	M	R	2,3,4	1,2a		2
Sulochana Devi	511187C	48	F	L	1,3	1,3	3	0
Chandan Dey	528466C	42	M	R	1,3	2a	1	0
Susanta Saha	591083C	31	M	L	1,3	1,2a	2	2
Narayana Swamy	097811B	52	M	R	1 & 3	1	1	2

Angiogram	EMG	Year	Operation
0	0	1997	1
2	0	2000	1
2	0	2002	1
0	0	2004	1
2	0	2004	1
2	0	2004	1
0	0	2005	1
2	0	1997	1

Findings
Complete cervical rib. Right subclavian artery stenosis
Complete cervical rib. Left subclavian artery stenosis
Complete cervical rib. Left subclavian artery aneurysm
Right SCA Aneurysm. Complete cervical rib
Cervical rib attached to first rib. Left subclavian artery absent pulsation beyond thyrocervical trunk
Complete cervical rib. Complete occlusion of R SCA second part occlusion of R brachial artery
Complete cervical rib L SCA aneurysm
Complete cervical rib. Thrombosed subclavian artery

Complication	Course	In Hospital Stay	Others	Follow Up
0	E	21		
0	UE	6		
0	UE	12		
0	UE	4	On aspirin and pletoz	1week. Well
0	UE	4		
0	UE	9	Anticoagulation	3 months, Well
0	UE	5	Aspirin	2 weeks. Well
0	UE	25		